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# Corrective Measures Study - Revision 4

Former J.H. Baxter & Co. Wood Treating Facility  
Arlington, Washington

**April 2017**

Prepared for:

**U.S. Environmental Protection Agency**

Region 10  
1200 Sixth Avenue  
Seattle, WA 98101

Prepared by:



55 SW Yamhill Street, Suite 300 Portland, OR 97204  
P: 503.239.8799 F: 503.239.8940  
[info@gsiws.com](mailto:info@gsiws.com) [www.gsiws.com](http://www.gsiws.com)

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Appendix B	Model Toxics Control Act Worksheets
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## **Acronyms and Abbreviations**

µg/L	microgram per liter
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
95% UCL	95 percent upper confidence limit on the mean
AMEC	AMEC Environment & Infrastructure, Inc.
AOC	Administrative Order on Consent
Arlington facility	Former J.H. Baxter & Co. wood-treating facility in Arlington, Washington
Baxter	J.H. Baxter & Co.
bgs	below ground surface
BNSF	BNSF Railway Company
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CLARC	Clean-Up Levels and Risk Calculations
CMO	corrective measure objective
CMS	Corrective Measures Study
COC	constituent of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
DCP	dichlorophenol
DNAPL	dense non-aqueous-phase liquid
DRO	diesel-range organic
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERH	electrical resistance heating
facility	Former J.H. Baxter & Co. wood-treating facility in Arlington, Washington
GAC	granular activated carbon
g/kg	gram per kilogram
gpm	gallon per minute
GSI	GSI Water Solutions, Inc.
IC	institutional control
ISCST3-PRIME	Industrial Source Complex-Short Term Plume Rise Model Enhancements
iSOC	in situ submerged oxygen curtain
LNAPL	light non-aqueous-phase liquid
MCL	Maximum Contaminant Level

mg/kg	milligram per kilogram
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NAPL	non-aqueous-phase liquid
NPDES	National Pollutant Discharge Elimination System
OSWER	U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
PCP	pentachlorophenol
pg/g	picograms per gram
POTW	publicly owned treatment works
PPE	personal protective equipment
PRG	Preliminary Remediation Goal
RCRA	Resource Conservation and Recovery Act
RRO	residual range oil
RSL	Regional Screening Level
Site	Former J.H. Baxter & Co. wood-treating facility, in Arlington, Washington, and areas of soil and/or groundwater affected by releases from the facility
Stella-Jones	Stella-Jones Corporation
TCP	trichlorophenol
TeCP	tetrachlorophenol
TEQ	toxicity equivalent
UCL	upper confidence limit
WAC	Washington Administrative Code

# 1.0 Introduction

The J.H. Baxter Project Team, consisting of J.H. Baxter & Co. (Baxter) and GSI Water Solutions, Inc. (GSI), has prepared this revised Corrective Measures Study (CMS) for the former Baxter wood-treating facility located at 6520 188<sup>th</sup> Street NE in Arlington, Washington (Arlington facility or facility [Figure 1-1]). The original text, tables, and figures of this report were prepared by AMEC Environmental & Infrastructure, Inc. (AMEC), and submitted to the U.S. Environmental Protection Agency (EPA) as *Corrective Measures Study – Revision 3*, dated April 2013. GSI has revised the version 3 CMS report to address comments received by Baxter from EPA in a letter dated July 16, 2015, a letter prepared by Battelle for EPA dated September 15, 2016, and based on discussions during a meeting with EPA and Battelle on December 14, 2016.

This revised CMS is being implemented pursuant to Paragraph 53 of the EPA Administrative Order on Consent (AOC) dated April 30, 2001 (EPA, 2001). CMS activities are consistent with guidance provided by EPA in the Resource Conservation and Recovery Act (RCRA) Corrective Action Plan (Final), dated May 1994 (EPA, 1994); the Corrective Action Advance Notice of Proposed Rulemaking (EPA, 1996); and the AOC.

## 1.1 Purpose and Objectives

The purposes of this document are to:

- Define corrective measures objectives (CMO) for the Baxter Arlington site, which includes the Arlington facility and areas of soil and groundwater affected by releases from the facility.
- Present proposed cleanup levels for constituents of concern (COC).
- Present corrective measures alternatives developed for the facility based on the results of the previously completed site investigation (SI) (Baxter, 2005), subsequent supplemental facility investigations (Premier, 2011), CMS version 2 and 3 (Baxter, 2011 and 2013) Source Area Investigation and Chemical Oxidation Bench Study Results (2014), Recirculation Trench Rehabilitation and iSOC installation Field Work Summary (2015a), Optimization Support Former J.H. Baxter & Co. Wood Treating Facility Site (2016a) and the subsequent meeting with EPA and Battelle in December 2016.
- Present the results of the pilot study conducted at the facility.

COCs, the affected media, and the potential receptors and exposure pathways were identified during the SI for each area of the facility. Functional and quantitative remedial action objectives are developed in this CMS to address conditions where concentrations of COCs are greater than proposed cleanup levels. EPA will develop final cleanup levels as part of the remedy selection process.

Corrective measures technologies that were potentially applicable to the remediation of affected media and COCs were identified and screened. Those technologies that were advanced through the screening process then were combined and developed into corrective measures alternatives for further evaluation.

The objective of the evaluations conducted in this CMS is to identify and select a technically responsive and cost-effective set of corrective measures to be implemented at the Arlington facility.

## **1.2 Document Overview**

This CMS includes the following sections:

- **Introduction (Section 1):** Describes the purpose and objectives of the CMS and provides an overview of the report contents and organization.
- **Environmental Setting and Facility History (Section 2):** Provides a brief description of the operations and history, environmental history, and current conditions at the Arlington facility.
- **Proposed Cleanup Levels (Section 3):** Evaluates the regulatory requirements applicable to the Arlington facility and develops proposed cleanup levels that are used to determine affected areas requiring corrective action.
- **Findings of Previous Investigations (Section 4):** Summarizes the findings of the completed SI and supplemental facility investigations performed since 2005; and compares the results to the proposed cleanup levels to identify affected areas requiring corrective action.
- **Conceptual Site Model (Section 5):** Summarizes the conceptual site model (CSM) developed from the SI and supplemental facility investigations performed since 2005.
- **Corrective Measures Considerations (Section 6):** Describes features of the facility operations and subsurface conditions that must be considered as part of the proposed corrective measures.
- **Corrective Measures Objectives (Section 7):** Provides a discussion of applicable cleanup requirements, cleanup levels, qualitative and quantitative corrective measure objectives, and special conditions at the Arlington facility that affect the selection of corrective measures.
- **Technology Screening (Section 8):** Describes the screening of potentially applicable technologies to address subsurface soil and groundwater cleanup at the facility.
- **Corrective Measures Alternatives (Section 9):** Describes the corrective measures alternatives evaluated for the Arlington facility.

- **Detailed Evaluation of Alternatives (Section 10):** Provides a detailed analysis of each alternative for each balancing criterion.
- **Comparative Evaluation of Corrective Measures Alternatives (Section 11):** Provides a comparison of each corrective measure alternative to each of the other alternatives.
- **References (Section 12):** Provides a list of references cited in this document.
- **Limitations (Section 13):** States that this document was prepared for the exclusive use of Baxter and EPA.

The following appendices are included in this document:

- **Appendix A: Data Tables.** Soil and groundwater sampling results collected during the SI and Supplemental Groundwater Investigation and used in this CMS.
- **Appendix B: Model Toxics Control Act Worksheets.** The worksheets to calculate Model Toxics Control Act (MTCA) Method C cleanup levels.
- **Appendix C: Cost Worksheets.** Detailed cost data for each corrective measure alternative.
- **Appendix D: Groundwater Hydrographs.** Groundwater hydrographs that were generated using data collected during the pilot study and subsequent monitoring.
- **Appendix E: Groundwater Elevation Data.** Groundwater elevation contour maps for the facility since 2008.
- **Appendix F: Pentachlorophenol Isopleth Maps.** Figures showing pentachlorophenol (PCP) concentrations in groundwater since 2008.
- **Appendix G: Groundwater Flow Modeling.** A summary of the groundwater modeling activities conducted during the evaluation of Alternative 6.
- **Appendix H: Biological and ISCO Treatability Studies.** Source area and chemical oxidation study results from December 23, 2014 AMEC report.

## 2.0 Environmental Setting and Facility History

This section provides background information on the Arlington facility, including its location and the history, nature, and extent of facility-related releases. The existing features of the Arlington facility are shown in Figure 2-1.

### 2.1 Facility Location

The Arlington facility is a wood preserving operation that occupies approximately 57 acres. Its primary business is the manufacture and preservation of telephone poles and other wood products. The facility is located in southwestern Arlington, Washington, at 6520 188<sup>th</sup> Street NE; it is southeast of the intersection of 67<sup>th</sup> Avenue NE and 188<sup>th</sup> Street NE.

For discussion purposes in this CMS, the property currently or previously owned by Baxter will be divided into four parcels, as shown in Figure 2-2 and described below:

- **Parcel A** is approximately 17 acres and includes the Main Treatment Area, where wood is treated, and the Treated Pole Storage Area, where treated poles are stored.
- **Parcel B (Untreated Pole Storage Area)** is approximately 28 acres and includes the area south of Parcel A where untreated poles are peeled (if necessary) and stored.
- **The Closed Woodwaste Landfill** is approximately 5.83 acres with the landfill footprint occupying 4.7 acres. The landfill was used for disposal of bark and wood shavings from pole-peeling operations. The Woodwaste Landfill was closed during the early 1990s.
- **The Northwest Parcel** is a 5-acre property purchased by Baxter in 2003. This property was recently sold although Baxter retains access to the groundwater monitoring wells located on the property.

These four parcel designations are defined solely to facilitate evaluation in this CMS. Current conditions of these four parcels and areas hydraulically downgradient of the facility are described in Section 2.5. Results from the SI and supplemental facility investigations are summarized in Section 4.

### 2.2 Environmental Setting

This section describes the environmental setting, including geology, hydrogeology, and other environmental conditions.

### **2.2.1 Regional Geology**

The Arlington facility lies in the Marysville Trough, a broad outwash plain located generally between Arlington and Marysville, Washington. The trough originally was carved by riverine and/or glacial erosion and then filled with a thick sequence of recessional outwash (coarse-grained glacial deposits). The recessional outwash deposits are estimated to be at least 100 feet thick in the area of the facility (Minard, 1985; Newcomb, 1952). Figure 2-3 presents a regional geologic map and cross section across the Arlington facility.

The Getchell Hill upland lies to the east of the facility. This glaciated upland sequence includes a till cap underlain by a thick sequence of advance outwash (fine-grained glacial deposits). The advance outwash deposits have been mapped to a thickness of up to 250 feet (Minard, 1985); however, most of these deposits were scoured and replaced by the recessional outwash of the Marysville Trough. The advance outwash deposits are underlain by fine sand, silt, and clay of the Transitional Beds Unit (Minard, 1985).

### **2.2.2 Regional Hydrogeology**

Regional groundwater flow directions in the outwash deposits are to the north and northwest, with a groundwater divide estimated to lie about 1 mile south of the Arlington facility (Figure 2-4) (USGS, 1997). Portage Creek, a tributary to the Stillaguamish River, lies approximately 5,000 feet north and northwest of the facility and is likely the principal discharge point for groundwater in the outwash deposits (Newcomb, 1952).

The facility also lies on the northernmost boundary of the Quilceda Creek watershed. In this area, surface water flow from the Getchell Upland to the east is directed to a manmade ditch that flows south along the BNSF Railway Company (BNSF) railroad tracks on the east side of the facility (Figure 2-1). A network of drainage ditches conveys surface water from the ditch bordering the facility to Quilceda Creek approximately 2 miles south of the Arlington facility.

### **2.2.3 Local Hydrostratigraphic Units**

Lithologic data collected from the facility have been used to define five distinct hydrogeologic units at the Arlington facility: Fill Material, Gravelly Sand, Fine to Medium Sand, Coarse Sand and Gravel, and Silt and Clay. These units are described briefly in the following paragraphs. The lithology is illustrated further in the four cross sections included as Figures 2-5 through 2-8. Figure 2-8 is a cross section that extends from the Main Treatment Area to the farthest downgradient well, and includes the approximate location of the dissolved-phase PCP plume discussed in Section 4.

**Fill Material:** Various fill materials are present at the Arlington facility, including woodwaste and backfill material. Typical depths of fill range from zero to 4 feet below ground surface (bgs);

however, fill has been observed at depths up to 15.5 feet bgs in the Main Treatment Area. Typically, these fills are distinguished from native material based on the presence of wood chips, organic material, charcoal, and higher silt content.

**Gravelly Sand:** This unit is the uppermost native material at the Arlington facility and is present below the Fill Material. This unit typically occurs from zero to 4 feet bgs, depending on fill thickness, to a depth of 15 to 25 feet bgs; however, gravelly sand has been observed as deep as 44 feet bgs. This unit is typically gray to brown gravelly sand with little silt.

**Fine to Medium Sand:** This unit typically is present beneath the Gravelly Sand at depths below 15 to 46.5 feet bgs, depending on the location at the facility. This unit typically contains small amounts of silt.

**Coarse Sand and Gravel:** This unit is present beneath the Fine to Medium Sand at depths of approximately 40 to 50 feet bgs. This unit consists of coarse sand with gravel and silt.

**Silt and Clay:** This unit is present beneath the Coarse Sand and Gravel at depths of approximately 100 feet bgs or greater. This unit consists of dense silt to dense clay.

## **2.2.4 Local Hydrogeology**

Groundwater is present beneath the facility at depths between 8 and 44 feet bgs, depending on time of year and location within the facility. Groundwater elevations are highest on the south and east sides of the facility. Seasonal water level fluctuations average approximately 4 to 5 feet; however, fluctuations of 10 to 15 feet have been observed in response to long-term precipitation cycles. Data indicate that groundwater elevation is directly related to the amount of precipitation at the facility. Generally, the first and second quarters show the highest groundwater elevations and the fourth quarter the lowest groundwater elevations.

Shallow groundwater elevation contour maps for Quarters 1-4, 2016 are presented in Figures 2-9 through 2-12, respectively, and for the deep groundwater Quarters 1-4, 2015 in Figures 2-13 through 2-16, respectively. These potentiometric surface maps are derived using data from wells installed during early investigations, the SI, pilot study (Baxter, 2007b), and supplemental groundwater investigation (Premier, 2011). Groundwater generally flows to the northwest. Hydraulic gradients vary across the facility, indicating differences in aquifer permeability. The recirculation system also affects hydraulic gradients in the vicinity of the system.

Bail test data from facility wells and grain size analysis (Hazen's test) from subsurface soil samples were used to estimate hydraulic conductivity. Hydraulic conductivity values range from 2 to 20 feet/day in the Fine to Medium Sand, and 100 to 150 feet/day in the Gravelly Sand.

Based on the hydraulic conductivity data, observed gradients from October 1999, and an assumed porosity of 0.3, groundwater flow velocities are estimated to be between 0.2 and 2.0 feet/day in the Fine to Medium Sand (Main Treatment Area), and 0.4 to 5.0 feet/day in the Gravelly Sand (northwestern portion of the facility).

### **2.2.5 Surface Water**

The Arlington facility is situated within the Marysville Trough glacial outwash plain. The outwash plain consists of sands and gravels that drain readily, leaving few natural surface water drainage features. Because of the internal drainage, the majority of the precipitation in the area infiltrates and becomes part of the groundwater system. Groundwater in the area flows primarily to the north-northwest toward the Portage Creek Valley (USGS, 1997 [Figure 2-4]). The closest surface water feature is a ditch along the eastern boundary of the facility (Figure 2-1).

Stormwater runoff that does not infiltrate into the ground is contained at the facility and treated before discharge into a permitted infiltration gallery.

Surface water and sediment have been eliminated from consideration in this CMS because of upgrades to the collection system installed by Baxter, and the construction and operation of the stormwater treatment system.

Process water and oil removed during the stormwater treatment process are managed separately from stormwater. Process water, as well as any stormwater falling on the drip pads and aprons, is transferred to an oil/water separator, where the oil is recovered and recycled in the system in accordance with RCRA. Activated carbon is used to treat process water leaving the oil/water separator. The treated water is sent to the cooling tower for use in cooling condensers or recycled in the treatment process.

### **2.2.6 Surrounding Land Use**

The facility lies in an area zoned Industrial by the City of Arlington. Land to the north, south, east, and west is also zoned Industrial. The closest property zoned Residential is 300 feet to the east and hydraulically upgradient of the facility, and is separated from the facility by other industrial land use and 67<sup>th</sup> Avenue NE. Non-conforming-use residences are present on properties adjacent to the facility to the northwest and southeast. A mobile home park lies to the northwest, approximately 400 feet from the facility boundary. A single-family residence lies southeast of the facility on a parcel that is bordered by the Untreated Pole Storage Area on three of four sides (Figure 2-2). The northwest parcel where the deep wells are located was purchased by Yacht Properties and is used for commercial/industrial uses. Access is available to the wells for the purpose of sampling and maintenance.

### **2.2.7 Groundwater Use**

The Marysville Trough comprises a large unconfined aquifer that extends from Arlington to Marysville (Figure 2-4). The aquifer is estimated to extend to a depth of 100 to 150 feet bgs. Because of the highly productive nature of the aquifer, there is considerable use of this resource for domestic and industrial water supply.

In 1988, Baxter conducted a beneficial use survey of water supply wells in the area (EMCON, 1989). Baxter updated this survey in 2000 and 2001 (Hart Crowser, Inc., 2000 and 2001). Within the survey area, 26 water wells were identified. Of those, 21 are being used for water supply (i.e., domestic, irrigation, or industrial). The other five wells have been abandoned (Hart Crowser, Inc., 2001). A City of Arlington water supply well is located approximately 1,500 feet west of the facility.

From June 2001 to January 2003, Baxter conducted semiannual monitoring of drinking water in 21 offsite drinking water wells. The purpose of the drinking water sampling was to determine if historical operations at the Arlington facility had affected drinking water in neighboring wells. A survey of drinking water wells in the area around the Arlington facility was conducted by reviewing state water well databases and city water service records, and by completing a door-to-door survey of residents in the surrounding area (Baxter, 2005).

All functioning drinking water wells identified in the survey were sampled and analyzed for PCP and tetrachlorophenols (TeCP). No PCP or TeCP were detected in any of the wells during the 2-year period (Baxter, 2004). EPA collected split samples in January 2002, which confirmed Baxter's sampling results (Baxter, 2004). Based on these results, EPA determined that drinking water well sampling could be discontinued. In 2010, Baxter performed an updated survey of drinking water wells near the facility. Based on a review of well logs and water rights, no new drinking wells have been established since the drinking water well survey performed in 2001 (Premier, 2010).

## **2.3 Previous Investigations**

Environmental investigations have been conducted at the Arlington facility since 1988. The following is a brief list of the completed investigations:

- Closed Woodwaste Landfill Investigations (1988)
- Closed Woodwaste Landfill monitoring (ongoing)
- Soil and Groundwater Investigation (1990)
- Site Hazard Assessment (1992)

- National Pollutant Discharge Elimination System (NPDES) Groundwater Monitoring (2000 - 2005)
- NPDES Stormwater Monitoring (1994 - 2002)
- NPDES Lysimeter Monitoring (2001 - 2005)
- Polychlorinated dibenzo-p-dioxins (PCDD)/polychlorinated dibenzofurans (PCDF) Study (1997 - 1998)
- Drinking Water Well Sampling Program (2001 - 2003)
- All Known and Reasonable Measures of Prevention, Control, and Treatment Study, (1997)
- Remedial Investigation (1999 - 2001)
- Site Investigations (2002 - 2004)
- Corrective Measure Study – Revision 1 (2007) Remedial Action Pilot Study Construction (2008)
- Remedial Action Pilot Study monitoring (ongoing)
- Supplemental Groundwater Investigation (2010)
- State Waste Discharge Permit monitoring (ongoing)
- Corrective Measure Study – Revision 2 (2011)
- Corrective Measure Study – Revision 3 (2013)
- Source Area Investigation and Chemical Oxidation Bench Study Results (2014)
- Recirculation Trench Rehabilitation and iSOC installation Field Work Summary (2015a)
- Optimization Support Former J.H. Baxter & Co. Wood Treating Facility Site (2016a)
- Comments/Discussion Information on the Battelle Optimization Report for the Baxter Arlington Project (2016b)

The integrated results of these investigations through 2005 were discussed in the SI report (Baxter, 2005). Investigation results since 1998 are summarized in the Stand Alone Data Document (Baxter, 2015b). Key investigation information to the CMS are summarized in Sections 2-5 of this CMS Version 4.

## **2.4 Pilot Study**

A pilot study was conducted at the facility to evaluate the performance of an enhanced biodegradation recirculation system with passive light non-aqueous-phase liquid (LNAPL) recovery, which was the recommended corrective measure alternative to address known contamination

associated with the Main Treatment Area (Figure 2-2) in the original CMS (Baxter, 2007a). A pilot study was conducted to assess the performance of the alternative and the full-scale pilot system was installed in accordance with the Remedial Action Pilot Study Work Plan, which was submitted to EPA in September 2007 (Baxter, 2007b), and subsequent comments received from EPA. Installation was completed on January 30, 2008. The system was commissioned on January 31, 2008, and has been operating since then. A comprehensive Remedial Action Pilot Study Report, which provides detailed analysis of system performance through the first quarter 2010, was submitted to EPA in October 2010 (Baxter, 2010a).

In 2015, it was observed that the performance of the system had diminished and a system rehabilitation work plan was submitted to EPA (2015). There were frequent system shut downs because of high water alarms in the infiltration trench. Between July 29th and July 30th, 2015 GSI oversaw the installation of the 10 geotechnical borings within the recirculation trench. The locations of the borings within the trench were determined in relation to existing standpipe monuments and system as-built drawings. In general, the borings were installed to a depth of approximately 20 feet below ground surface (bgs) and were backfilled with 1-3" crushed concrete or ½-1½" limestone/basalt rock. Since the additional infiltration boring were installed, the system has been operating at approximately 50 gpm without any shut downs.

Section 9.2.4 (in this CMS) summarizes the implementation of the pilot study and results through 2016.

## **2.5 Current Facility Conditions**

The Arlington facility imports raw logs and processes them into utility poles. Processing activities include debarking, trimming, marking, seasoning, and treatment. The finished products are shipped to utilities and other users by truck or rail. Current features at the Arlington facility are shown in Figure 2-1.

On February 28, 2007, Baxter entered into an agreement with Stella-Jones Corporation (Stella-Jones), in which Stella-Jones has leased Parcels A and B of the facility (Figure 2-2) and has assumed operation of the wood-treating facility. Baxter retains ownership of the property and buildings. Baxter also retains control of all remediation work related to the AOC.

This section summarizes the current condition of the facility, including the history and operations at each of the parcels. In addition, the site investigation results for each parcel are described briefly.

## **2.5.1 Parcel A**

Parcel A (leased by Stella-Jones) consists of the Main Treatment Area and the Treated Pole Storage Area (Figure 2-2).

### **2.5.1.1 Main Treatment Area**

The Main Treatment Area is located in Parcel A in the central portion of the facility (Figure 2-2). Pole treating has been conducted in this area since the middle to late 1960s. Baxter purchased this parcel in 1970 and has continued wood-treating operations in this area. Numerous process upgrades and improvements have been made since Baxter purchased the property. Many of the upgrades were designed to reduce or eliminate the potential for releases of facility-related chemicals. Specific improvements made to address historical releases included the excavation and disposal of ditch material containing low concentrations of PCP in 2004 (Baxter, 2005).

Existing features in the Main Treatment Area include:

- Three retorts used for vacuum drying and pressure treating of wood poles with heated PCP in carrier oil solution - an oil/water separator, oil recycling, and activated carbon water treatment system
- One in-ground butt tank used for partial immersion of pole butts in heated copper naphthenate solution and PCP
- Butt-treating plant and main treatment plant tank farms in secondary containment structures
- Subpart W drip pads with paved aprons
- Process water collection and treatment system (located in the main treatment plant)
- Canopy-covered tram storage area next to main treatment building
- Two natural-gas-fueled kilns for pole drying
- PCP storage building

The results of the SI indicate historical releases of PCP, diesel-range organics (DRO), and polycyclic aromatic hydrocarbons (PAH) in Parcel A. The facility-related chemicals detected in this area likely originated from butt tank overflows and releases of treating solutions during historical operations. See Section 4 for more information on the SI and results of subsequent investigations.

### **2.5.1.2 Treated Pole Storage Area**

The Treated Pole Storage Area, which is part of Parcel A, is located in the northern portion of the facility, north of the Main Treatment Area (Figure 2-2). Treated pole storage has been conducted in this area since the middle to late 1960s. Baxter purchased this parcel in 1970 and continued wood-treating and pole storage operations. Specific improvements made to address historical releases

include the excavation and disposal of ditch sediments containing low concentrations of PCP in 2004 (Baxter, 2005).

Existing features in the Treated Pole Storage Area include:

- Pressure-treated and butt-treated poles stored on skids
- A stormwater collection system
- Office, machine shop, and main shop buildings

### **2.5.2 Parcel B (Untreated Pole Storage Area)**

Parcel B consists of the Untreated Pole Storage Area (leased by Stella-Jones), located in the southern portion of the facility (Figure 2-2). It was purchased by Baxter in the early 1970s and had no prior industrial usage. A portion of the parcel is used to peel poles.

Existing features in the Untreated Pole Storage Area include:

- Untreated pole storage
- Lunch room
- Wire storage building
- Incisor
- Framing building
- Pole peeler
- Stormwater treatment system and infiltration gallery

Data from the SI show that some detectable levels of COCs are present in Parcel B, though none of the constituents related to wood-treating has been detected above proposed cleanup levels (Section 3). Therefore, no additional investigation or corrective action is warranted for this parcel.

### **2.5.3 Closed Woodwaste Landfill**

The Closed Woodwaste Landfill is located on the 7-acre plot west of Parcel A and north of Parcel B (Figure 2-2). The landfill is a separate tax parcel from Parcels A and B. This former gravel pit contains wood shavings from peeling operations. In the early 1990s, the gravel pit/landfill was capped with clean soil and certified as closed as a monofill landfill through the Snohomish County Health District. A stormwater retention pond on the southwestern corner of the parcel collects runoff from the landfill cap. Quarterly groundwater monitoring is conducted in accordance with Snohomish County Health District post-closure requirements. No activities for this parcel were

included in the SI, and the landfill is not an area of concern. Given that the closed landfill is not an area of concern, it will not be considered further in this CMS.

#### **2.5.4 Northwest Parcel**

The Northwest Parcel was purchased by Baxter in 2003 and is located in the northwestern portion of the facility (Figure 2-2). The parcel is zoned Industrial and houses a small office building and storage building. This parcel was sold in 2016 to Yacht Properties.

The results of the SI and subsequent groundwater investigations indicate the presence of a groundwater plume (primarily PCP) beneath the Northwest Parcel. The plume extends across 188<sup>th</sup> Street NE to the northwest in the direction of groundwater flow. The groundwater plume originates in the Main Treatment Area (Parcel A). See Section 4 for more information on the SI, remedial action pilot study monitoring, and Supplemental Groundwater Investigation results.

## **3.0 Proposed Cleanup Levels**

This section outlines the approach used to develop proposed cleanup levels that were used for this CMS. The proposed cleanup levels must be established for affected media and must be appropriate for the land use and relevant exposure pathways. Affected media identified in the SI include soil and groundwater underlying Parcel A and groundwater extending to the northwest beneath the Northwest Parcel. Affected media identified during supplemental groundwater investigations also include groundwater hydraulically downgradient of the Northwest Parcel. Air monitoring conducted at the Arlington facility indicates that current and historical releases are not affecting ambient air and no proposed cleanup levels are needed for air. In addition, stormwater runoff that does not infiltrate into the ground is contained within the facility boundary and treated before discharge into a permitted infiltration gallery. Therefore, proposed cleanup levels are not needed for surface water or sediment.

As noted previously, the Arlington facility is zoned for heavy industrial use. The facility has a long industrial history and it is expected to remain under industrial use for the foreseeable future. The Arlington facility has not been used for residential purposes. Based on the historical and expected future land use, Baxter anticipates that the proposed cleanup levels used for the CMS will be based on industrial land use rather than unrestricted land use and that institutional controls (IC) restricting use of the facility will be part of the remedy selected. It is also expected that any approval issued by EPA regarding corrective measures at the Arlington facility will specify that ICs are necessary to protect human health and the environment.

EPA will develop the final cleanup levels for the facility, and these final cleanup levels may be different from the proposed cleanup levels used in this CMS. The proposed cleanup levels were developed as described in this section and were used (1) to evaluate which areas of the facility require corrective actions and (2) to identify and evaluate corrective measures alternatives. To establish the scope and objectives of corrective measures, data from previous investigations will be compared to proposed cleanup levels that are considered appropriate for the Arlington facility and for the purposes of this CMS.

### **3.1 Proposed Groundwater Cleanup Levels**

The proposed groundwater cleanup levels are presented in Table 3-1. Proposed groundwater cleanup levels are based on a general analysis of groundwater use and comply with Washington State cleanup regulations, specifically the MTCA methodology for establishing Method B cleanup levels. MTCA Method B cleanup levels were used for groundwater because they are applicable to all parcels and because groundwater flow to locations beyond the Baxter property has occurred;

therefore, Method C groundwater cleanup levels are not appropriate. The highest use considered for groundwater beneath and downgradient from the Arlington facility is drinking water.

The MTCA regulations (Washington Administrative Code [WAC] 173-430-720) specify the methodology for development of MTCA Method B groundwater cleanup levels. Under WAC 173 340 720(4)(b)(ii), Method B cleanup levels for groundwater may exclude protection of surface water if it can be demonstrated that hazardous substances from a site are not likely to reach surface water. Based on the SI and ongoing monitoring at the facility, data from monitoring wells indicate that the plume is either stable or shrinking. Before implementation of the Pilot Study, Baxter conducted a Mann-Kendall trend analysis for two primary wells (MW-3 and MW-15) in accordance with the Guidance for Data Quality Assessment, Practical Methods for Data Analysis (EPA, 2000a). The results of the trend test indicated that the PCP trend was stable in MW-3 and decreasing in MW-15.

Groundwater data collected from monitoring wells indicate that constituents released at the Arlington facility have been detected at concentrations above EPA Maximum Contaminant Levels (MCL) in groundwater downgradient of the Baxter property. However, surface water quality standards are not considered appropriate or applicable to groundwater beneath the Arlington facility because of the limited extent of affected downgradient groundwater and the large distance to the principal groundwater discharge point at Portage Creek. Therefore, proposed groundwater cleanup levels will be based solely on the use of groundwater for drinking water.

The process used to develop proposed cleanup levels for groundwater is outlined below. Because the highest groundwater use is for drinking water, the proposed cleanup levels are based on criteria for drinking water. A hierarchical process was used to establish the proposed cleanup levels, as follows:

1. The MCLs established for the primary drinking water standards (Code of Federal Regulations [CFR], Title 40, parts 141.61 and 141.62) were used to establish proposed groundwater cleanup levels.
2. For constituents with no MCL, a standard MTCA Method B cleanup level for drinking water was obtained from the Washington State Department of Ecology (Ecology) Clean-Up Levels and Risk Calculations (CLARC) Web site (Ecology, 2013).
3. If the MTCA Method B cleanup level for drinking water was not available from the CLARC Web site, the MTCA Method A groundwater cleanup level was used as the proposed cleanup level.
4. If no MTCA Method A cleanup level was available, EPA Regional Screening Levels (RSL) for tap water were used as the proposed cleanup level.

5. If no MCL, MTCA Method B or Method A cleanup level, or EPA RSL for tap water was available, no proposed cleanup level was established for that constituent.

The proposed groundwater cleanup levels for the Arlington facility are summarized in Table 3-1. Table 3-1 also shows the MCLs, MTCA Method B cleanup levels, MTCA Method A cleanup levels, and EPA RSLs. For carcinogenic PAHs (cPAH), the MTCA Method B cleanup level for benzo(a)pyrene was compared to calculated total toxicity-equivalent concentrations for cPAHs, according to WAC 173-340-708(8)(e). The total toxicity-equivalent concentrations of cPAHs is calculated following each routine monitoring event using analytical data from groundwater samples. Following the criteria above, the RSLs for individual cPAHs would be used only if MTCA Method B or MTCA Method A cleanup levels were not available.

## **3.2 Proposed Soil Cleanup Levels**

The proposed soil cleanup levels are shown in Table 3-2. Proposed cleanup levels for soil were developed using MTCA methodology based on industrial land use, assuming that the final corrective measures will include appropriate ICs for industrial land use. Two sets of proposed soil cleanup levels were established for the Arlington facility: one set for Parcel A and one set for Parcel B. This is because the groundwater under Parcel A has been impacted by contaminants in soil, but data collected from the Site show that the groundwater under Parcel B has not been impacted and is not expected to be impacted in the future, as described in Section 3.2.2. Therefore, the soil cleanup levels for Parcel A incorporate generic values for the protection of groundwater, and the proposed soil cleanup levels for Parcel B reflect that soil concentrations are already protective of groundwater (see Section 3.2.2). The proposed soil cleanup levels for each of the parcels were established in accordance with MTCA regulations.

The MTCA regulations (WAC 173-340-745) establish procedures to develop Method C cleanup levels for industrial soil. MTCA Method C procedures employ a risk-based evaluation of potential human health and environmental exposures based on an industrial exposure scenario. This evaluation considers potential exposure pathways relevant to soil contaminants, including direct contact/ingestion, volatilization and inhalation, and desorption to groundwater. As noted previously, the chemicals used at the Arlington facility were semivolatile constituents with low volatility; the volatilization and inhalation pathway therefore is not considered appropriate for establishing cleanup levels. Proposed soil cleanup levels are presented for Parcels A and B in the following subsections.

### **3.2.1 Parcel A**

The proposed soil cleanup levels for Parcel A (Figure 2-2), as shown in Table 3-2, are based on industrial land use. Given that both soil and groundwater at Parcel A have been affected by

historical releases, proposed soil cleanup levels must be established so that they are protective of groundwater.

The following process was used to determine proposed soil cleanup levels for Parcel A:

1. MTCA Method C soil cleanup levels based on direct contact/ingestion were obtained from the CLARC Web site (Ecology, 2013).
2. For each soil constituent, MTCA Method C soil cleanup levels protective of groundwater were calculated using the Ecology spreadsheet tool MTCASGL11.0 (Ecology, 2006). The proposed groundwater cleanup levels listed in Table 3-1 were used in the calculations as the groundwater standard. Default parameters for the MTCASGL model and toxicity parameters were obtained from the CLARC Web site.
3. The MTCA Method C cleanup level (i.e., the lower cleanup level from steps 1 and 2 above) was selected as the proposed soil cleanup level for Parcel A.
4. For constituents with no available MTCA Method C cleanup levels, the MTCA Method A cleanup level for industrial facilities was selected as the proposed soil cleanup level.
5. For constituents with no available MTCA Method C or Method A soil cleanup levels, the EPA RSLs for industrial sites were selected as the proposed soil cleanup levels.
6. If no MTCA Method C or industrial Method A cleanup level and no industrial RSL was available, no proposed cleanup level was established for that constituent.

The MTCA regulations (WAC 173-340-747) establish the process for deriving soil cleanup levels that are protective of groundwater. For Parcel A, partitioning calculations were performed to calculate soil concentrations protective of groundwater. The partitioning calculations were done using the Ecology spreadsheet MTCASGL11.0 (Ecology, 2006), using toxicological parameters obtained from the CLARC Web site (Ecology, 2013). Default values were used for the other model parameters. Because groundwater cleanup levels were calculated as a total toxicity-equivalent factor as described in Section 3.1, the individual cPAH RSLs were used in the protection-of-groundwater calculations where individual MTCA cleanup values were not available. Copies of the spreadsheets for these calculations are included as Appendix B. The proposed soil cleanup levels for Parcel A are summarized in Table 3-2.

### **3.2.2 Parcel B**

Proposed soil cleanup levels for Parcel B (Figure 2-2) were established using a procedure similar to that used for Parcel A. However, the approach used for assessing protection of groundwater for Parcel B is different from that used for Parcel A.

Several alternate approaches are presented under the MTCA regulations for deriving soil concentrations for protection of groundwater (WAC 173-340-747). One of the methods cited under the rule provides for an empirical demonstration (WAC 173-340-747[3][f]) and 173-340-747[9]) that existing soil concentrations will not cause an exceedance of groundwater cleanup levels. The regulation specifies that this demonstration be based on site-specific groundwater and/or soil data.

Site-specific data collected for the SI and during routine groundwater monitoring demonstrate that current constituent concentrations in Parcel B soil are not adversely affecting groundwater. As is further described in Section 4, concentrations of COCs in groundwater in Parcel B are below proposed cleanup levels based on direct contact/ingestion. Groundwater samples have been collected for multiple rounds at two groundwater monitoring wells: MW-14 (two rounds since 2001) and BXS-4 (13 rounds since 2001). Seven direct-push groundwater samples were collected as part of the SI at locations SB-52 through SB-58. In addition, soils with detectable concentrations of COCs in Parcel B are confined to the near surface (generally less than 5 feet in depth), whereas the depth to groundwater is more than 20 feet (Figure 2-5). Thus, groundwater is separated from the COCs present in soil by approximately 15 to 20 feet. The time frame that these COCs likely have been present is long enough that future migration to groundwater is extremely unlikely. Based on the site-specific data discussed above, existing contaminant concentrations in affected soil at Parcel B are protective of groundwater.

The following procedure was used to determine proposed soil cleanup levels for Parcel B:

1. MTCA Method C soil cleanup levels based on direct contact/ingestion were obtained from the CLARC Web site (Ecology, 2013).
2. For those constituents with no available MTCA Method C cleanup level, the MTCA Method A cleanup level for industrial facilities was selected as the proposed soil cleanup level.
3. For constituents with no available MTCA Method C or Method A soil cleanup level, the EPA RSLs for industrial sites were selected as the proposed soil cleanup level.
4. If no MTCA Method C or industrial Method A cleanup level and no industrial RSL was available, no proposed cleanup level was established for that constituent.

The proposed soil cleanup levels for Parcel B will ensure that soil is protective of industrial use. Existing concentrations of COCs in soil in Parcel B are protective of groundwater, based on the site-specific evaluation presented above and discussed further in Section 4.2. Proposed soil cleanup levels for Parcel B are summarized in Table 3-2.

## 4.0 Findings of Previous Investigations

This section describes the distribution of COCs in soil and groundwater throughout the different areas of the facility that will be used as the basis for remedy design. This summary is based on the findings of multiple facility investigations; the most comprehensive investigation is presented in the SI (Baxter, 2005). Other resources documenting the extent of COCs in groundwater since completion of the SI include the Stand-Alone Data Document (Baxter 2016), Remedial Action Pilot Study Report (Baxter, 2010a), and a supplemental groundwater investigation (Premier, 2011). Collectively, the SI and subsequent reports provide data tables and figures that quantify the distribution of COCs in surface soil, subsurface soil, sediment, and groundwater both on and off the Baxter property. These tables and figures are included in this CMS by reference; data summary tables, including results for investigations performed since the SI, are included in Appendix A.

Based on the results of previous investigations, PCP has been found to be the most widely distributed COC in groundwater. PCP has high solubility and is mobile in the environment. Therefore, PCP has been used as the primary indicator constituent for groundwater and has been used to assess the extent of affected groundwater for the Arlington facility.

Tables 4-1 and 4-2 present the highest detected concentrations of COCs in groundwater and soil, respectively, in Parcels A and B, and also show the proposed cleanup levels developed in Section 3. As these tables show, only a limited number of COCs exceed proposed cleanup levels. The data used to develop Table 4-1 include groundwater sampling data collected since 2001. Table 4-2 is based on the data tables included as Appendix A. Appendix A contains data tables that support the descriptions of COC concentrations in Sections 4.1 and 4.2.

### 4.1 Parcel A

Parcel A includes the Main Treatment Area and the Treated Pole Storage Area (Figure 2-2). This section summarizes results of investigations for these two areas. Figure 4-1 shows the areas of Parcel A that historically have exhibited surface and subsurface soil and groundwater affected by COCs at concentrations above the proposed cleanup levels. The affected areas are described briefly below.

#### 4.1.1 Main Treatment Area

The Main Treatment Area has been used for treating poles since the 1960s and is the area at the Arlington facility where all treatment operations have occurred. This area is considered the source area for affected groundwater (Baxter, 2005).

#### **4.1.1.1 Surface Soil**

Results presented in the SI indicate the presence of COCs in surface soil in the Main Treatment Area. Samples were collected at one sample location (SS-24) from depth ranges that varied from zero to 2 inches up to 6 to 18 inches. Analytical results included concentrations of PCP (0.23 to 0.56 milligrams per kilogram [mg/kg]) that exceeded proposed cleanup levels. Samples collected for analysis of PCDD/PCDFs contained concentrations of 494 picograms per gram ([pg/g] 10 to 12 grams) toxicity equivalents (TEQ), which do not exceed proposed cleanup levels for soil. Near the Penta Storage Shed, one surface soil sample collected from the zero to 6-inch depth interval (SS-25) contained a concentration of PCP of 1.9 mg/kg, exceeding the proposed cleanup level for PCP.

#### **4.1.1.2 Subsurface Soil**

Investigations performed through the 2005 SI identified the presence of COCs in subsurface soils in portions of the Main Treatment Area. In general, samples collected and analyzed from borings drilled adjacent to the old butt tank, where several historical spills have been reported, contained the highest concentrations of COCs in subsurface soils in the Main Treatment Area. The areal extent of soil affected by facility COCs is shown in Figure 4-1. The locations of historical structures in the Main Treatment Area are shown on Figure 4-2.

Samples were collected at several depth intervals, with the shallowest interval being 4 to 6 feet and the deepest interval being 38 to 40 feet, at 13 sample locations (SB-35 through 42, SB-61 through 63, and MW-12 and MW-13). Analytical results showed concentrations of PCP (0.013 to 1,300 mg/kg), DROs (3,500 to 45,000 mg/kg), and multiple PAH compounds greater than proposed cleanup levels. Exceedances were observed at most depths, with the highest results generally coming from the sample collected at the depth interval of 10 to 12 feet at SB-39 and the sample collected at the depth interval of 32 to 34 feet at MW-13.

Low to non-detectable concentrations of COCs were reported for subsurface soil samples collected at depths of approximately 31 to 43 feet bgs to investigate the possible presence of COCs south, west, and east of the retorts (SB-41, SB-42, MW-10, and MW-11), and at 4 to 6 feet bgs in the area of the treatment solution spill from the old butt tank in 1990 (SB-47 through SB-51).

#### **4.1.1.3 Groundwater**

Groundwater monitoring wells in the Main Treatment Area are MW-1, MW-12, MW-13, MW-19, MW-20, MW-21, MW-25, and MW-32. The highest concentrations of COCs in groundwater were observed in MW-13, located near the old butt tank; these concentrations coincide with the presence of LNAPL.

Concentrations of COCs higher than proposed cleanup levels have been detected in well MW-32 (1,700 micrograms per liter [ $\mu\text{g/L}$ ] PCP) and MW-25 (240  $\mu\text{g/L}$  PCP).

#### **4.1.1.4 NAPL**

Residual NAPL was observed during installation of many of the pre-SI subsurface soil borings, as well as several borings installed during and after the SI. All of the borings in which residual NAPL was observed are located within the Main Treatment Area. Residual LNAPL in these borings was observed at depths ranging from 10 to 42 feet bgs. The bulk of the NAPL is residual in nature and located above the water table in the vadose zone. PCP was only used in a dry form and mixed with light mineral oil that consisted of a mixture of aromatic and aliphatic hydrocarbons. The density of the oil is 0.92 g/cc and the density of pure PCP is 1.98 g/cc. The dry PCP was dissolved into the oil with a resulting density of 0.973 g/cc which is an LNAPL. LNAPL has been observed in three monitoring wells (MW-12, MW-13, and MW-19) installed in this area. DNAPL has not been observed and based on the PCP usage, it is not anticipated to be present at the site. Figure 4-2 shows the distribution of residual NAPL. The depth of the NAPL is bounded by 12 borings which were advanced beneath the depth of NAPL presence.

MW-12 and MW-13 were installed as LNAPL recovery wells. Wells MW-19 through MW-21 were added as additional NAPL recovery wells in 2007 (Figure 4-2). In 2005, NAPL recovery was conducted by extraction from MW-12 and MW-13 using a submersible pump and bailers. Recovery resulted in little NAPL re-entering the wells. Therefore, sorbent socks were placed into the five extraction wells in March 2006. There total recover at MW-12 is approximately 8.4 gallons since 2005. Recovery from MW-13 is 0.75 gallons and 0.14 gallons was recovered from each MW-19 and MW-21. This results in 9.48 gallons of total LNAPL recovery between 2005 and 2015, or less than 1 gallon per year (see Figures 67 and 68 from the 2016 SADD report).

#### **4.1.1.5 Source Area Bench Studies**

Evaluations were conducted in 2014 on Source Area soils and groundwater to assess the biodegradation of the COCs and to assess oxidant demand and appropriate oxidants for the Site. Geochemical analysis found oxidative conditions in groundwater upgradient and anaerobic conditions within the source area. Analysis of biological parameters indicated that the PCP regulator gene and two other genes associated with oxidative degradation of PCP were present within source area soil samples. Geochemical and biological results indicate that site groundwater may be able to support aerobic degradation of PCP, however groundwater was deficient in nutrients nitrogen and phosphorus needed to further oxidative biological activity.

Total oxidant demand bench testing was conducted with permanganate, persulfate, and hydrogen peroxide. Bench scale results showed that alkaline activated persulfate was the most effective oxidant for reducing PCP concentrations amongst oxidant systems tested. The bench testing results also indicated that PCP is oxidized preferentially over the petroleum hydrocarbons under the alkaline conditions. The bench effectiveness testing recommended an alkaline activated

persulfate concentration of 23 g/kg for further pilot scale testing. The report summarizing this work and findings is provided in Appendix H.

#### **4.1.2 Treated Pole Storage Area**

The Treated Pole Storage Area includes a large portion of the Arlington facility located north of the Main Treatment Area and smaller areas surrounding the Main Treatment Area to the east, south, and west.

##### **4.1.2.1 Surface Soil**

PCP and PCDD/PCDFs have been detected in surface soils during previous investigations in the Treated Pole Storage Area. PCP concentrations in pre-SI surface soil samples ranged from 5.3 to 90 mg/kg, and PCDD/PCDF concentrations (TEQ) ranged from 4,700 to 6,400 pg/g TEQ. PCP concentrations in slightly deeper pre-SI samples (0.8 foot) at the same locations were much lower, ranging between 0.096 and 16 mg/kg.

Fourteen surface soil sample stations were established from a random grid in this area during the SI (locations SS01 through SS14). At each location, soil samples were collected from the zero to 2-inch depth interval and from the 6- to 18-inch depth interval. PCP concentrations ranged from 0.1 to 10.0 mg/kg in the zero to 2-inch depth interval and 0.018 to 2.0 mg/kg in the 6- to 18-inch depth interval, all of which are above the proposed cleanup level of 0.0158 mg/kg. PCDD/PCDF concentrations (TEQ) ranged from 87 to 645 pg/g, which are below proposed cleanup levels. Concentrations of COCs in samples collected during the SI were generally lower than those in pre-SI surface soil samples, but concentrations in many SI sample results were greater than the proposed cleanup levels (Appendix A).

##### **4.1.2.2 Subsurface Soil**

Subsurface soil samples were collected from four locations in the Treated Pole Storage Area (MW-10, MW-11, SB-2D, and SB-3D). Samples were collected from several depth intervals ranging from 4 to 6 feet up to 96 to 98 feet. Analytical results included concentrations of PCP above the proposed cleanup level (0.018 to 0.5 mg/kg) in samples collected at depths between 4 and 52 feet bgs. Samples collected at shallower and deeper depths had concentrations below the proposed cleanup level (Appendix A).

##### **4.1.2.3 Groundwater**

Twelve wells (HC-MW-5, HC-MW-6, MW-2, MW-3, MW-10, MW-11, MW-22, MW-23, MW-24, MW-26, MW-27, and MW-35) are considered to be associated with the Treated Pole Storage Area.

Wells HC-MW-5, MW-3, MW-10, MW-11, MW-22, MW-23, MW-24, MW-26, and MW-33 are located outside the Main Treatment Area near its outer boundary. Concentrations of COCs higher

than proposed cleanup levels (up to 2,400 µg/L PCP) were detected in samples collected from MW-3, which does not contain LNAPL and is located hydraulically downgradient (northwest) of the Main Treatment Area. Analytical results from MW-3 also have shown detections of DROs and PAHs (up to 9.92 µg/L total PAHs) above the proposed cleanup levels in samples collected since 2002 (Appendix A).

COCs have consistently been below proposed cleanup levels in samples collected from wells located upgradient of the source area (HC-MW-5, MW-10, and MW-11). Samples collected from wells within the Treated Pole Storage Area that are cross gradient from the source area (HC-MW-6, MW-2, MW-26, MW-27, and MW-35) have not exceeded proposed cleanup levels for PCP since 2001. Together, analytical data collected from wells inside the Main Treatment area and the Treated Pole Storage Area indicate the presence of a contaminant plume in groundwater extending from the Main Treatment Area to the northwest (Baxter, 2005 [Figure 4-1]).

### **4.1.3 Northwest Parcel and Downgradient Areas**

#### **4.1.3.1 Soil**

The SI results (Baxter, 2005) demonstrated that soils in this area were not affected by historical releases related to Arlington facility operations (Figures 2-2 and 4-1).

#### **4.1.3.2 Groundwater**

Wells HC-MW-7, MW-15 through MW-17, MW-29, MW-30, MW-31, MW-34, and MW-36 through MW-41 are located in the Northwest Parcel area. COCs have been detected in MW-15 with concentrations of PCP up to 790 µg/L, DROs up to 320 µg/L, and total PAHs up to 0.52 µg/L. Concentrations of COCs have been consistently below proposed cleanup levels in MW-16, MW-17, and HC-MW-7, which are located either downgradient or cross-gradient of MW-15 and near the property boundary.

Wells MW-29, MW-30, MW-31, MW-34, MW-36, and MW-37 were installed as part of the preferred alternative pilot study. PCP concentrations above cleanup levels have been detected at MW-29, MW-34, MW-36, and MW-37. The highest PCP concentrations in the Northwest Parcel were detected in samples collected from MW-29 (up to 1,600 µg/L), MW-34 (up to 1,900 µg/L), and MW-37 (up to 1,100 µg/L). However, PCP concentrations have dropped dramatically since installation of the pilot recirculation system (Appendix A and Appendix F). Groundwater samples from wells MW-30 and MW-31 have not exceeded proposed cleanup levels for PCP. Analytical results from these wells demonstrate a fairly narrow groundwater plume extending northwest from the source area in the Main Treatment Area toward the MW-29/MW-34 well pair and MW-37.

Wells MW-38 through MW-41 were installed in August 2010, during the Supplemental Groundwater Investigation, to characterize COC distributions deeper in the water-bearing zone.

Results show that PCP concentrations exceed proposed cleanup levels at MW-39 (up to 130 µg/L), MW-40 (up to 800 µg/L), and MW-41 (430 µg/L). Analytical results also indicate that PCP concentrations are below the proposed cleanup level of 1 µg/L at MW-38.

During the SI, well MW-18 was installed across 188th Street NE from the Baxter property, in an area hydraulically downgradient (i.e., northwest) from the Main Treatment Area. No COCs have been detected above proposed cleanup levels in well MW-18. As part of the Supplemental Groundwater Investigation, wells MW-42 and MW-43 were installed to monitor groundwater for COCs deeper within the water-bearing zone in areas located downgradient of the Northwest Parcel. Analytical data from samples collected from MW-42 indicate PCP groundwater concentrations (up to 44 µg/L PCP) above the proposed cleanup level. Analytical data from sample collected from MW-43 and four discrete groundwater samples collected between 80 and 110 feet bgs during MW-43 installation exhibited PCP concentrations below cleanup levels.

The PCP plume is consistent with the downward gradient at the Site and therefore, consistent with dissolved concentrations of PCP in groundwater migrating with groundwater flow. Groundwater concentrations downgradient of the system have fluctuated with system performance indicating when the system is operating well, concentrations decrease as expected.

All functioning offsite drinking water wells near the Arlington facility were sampled during four sampling events between June 2001 and January 2003. No PCP or TeCP was detected in any of these wells during the 2-year period; no further testing has been required by EPA.

Wells BXS-1, BXS-2, BXS-3, and MW-28 are located slightly south of wells located in the Northwest Parcel in the area of the Closed Woodwaste Landfill. In samples collected since 2001, dioxins/furans have been detected at BXS-1, BXS-2, and BXS-3 with TEQs below the 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD) proposed cleanup level. Additionally, PCP has been detected above the proposed cleanup level (up to 94 µg/L) at BXS-1, which is located hydraulically downgradient of the Main Treatment Area. PCP concentrations in groundwater samples collected from MW-28 have not exceeded the proposed cleanup level.

## **4.2 Parcel B (Untreated Pole Storage Area)**

Parcel B consists of the entire southern portion of the Arlington facility, as shown in Figure 2-2. Figure 4-1 shows the locations in Parcel B where sampling results have exceeded proposed cleanup levels. Tables 4-1 and 4-2 present the highest detected concentrations of COCs in groundwater and soil, respectively, in Parcels A and B, and also show the proposed cleanup levels. The following subsections discuss the SI results for Parcel B.

#### **4.2.1 Surface Soil**

There are 11 surface soil sample locations in this area (SS-15 through 22). At each location, soil samples were collected from the zero to 2-inch depth interval and from the 6- to 18-inch depth interval. Analytical results for all surface soil samples are below the proposed cleanup levels.

#### **4.2.2 Subsurface Soil**

Ten soil borings (SB-52 through SB-60, MW-14) were installed along the southern boundary of Parcel B to evaluate the potential for stormwater in this area to be a source of COCs to soil and groundwater. The borings were completed to depths ranging from 4 to 36 feet bgs. Residual range oil (RRO) was the only COC detected at concentrations above proposed cleanup levels in these subsurface soil samples in Parcel B. The general location of the affected soil near this boring is shown in Figure 4-1. This sample was collected at a depth of 4 to 6 feet bgs.

#### **4.2.3 Groundwater**

There are three groundwater monitoring wells in this area (MW-4, BXS-4, and MW-14). Additionally, seven direct-push locations (SB-52 through 58) were sampled for groundwater on Parcel B during the SI. COCs were not detected above the CMS-proposed cleanup levels in any groundwater samples collected from Parcel B during the SI (2001 through 2005). Data from previous investigations show that groundwater beneath Parcel B has not been affected by facility COCs (Appendix A).

### **4.3 Potential Air Emissions**

COC concentrations in air were evaluated by using the EPA Industrial Source Complex-Short Term Plume Rise Model Enhancements (ISCST3-PRIME) model to predict airborne COC concentrations at specific locations near the Arlington facility. A Tier II analysis resulted in no modeled COC concentrations in exceedance of applicable EPA Region 6 Ambient Air preliminary remediation goals (PRG).

Five soil samples were collected outside of the Arlington facility boundary as part of the air investigation to evaluate transport to soil by aerial deposition beyond the Baxter property boundary. Low concentrations of PCP and PAHs were detected in the offsite soil samples. PCDD/PCDFs also were detected in all soil samples outside the facility at concentrations ranging from 0.915 to 222.4 pg/g. It should be noted that the PCDD/PCDF concentrations at these off-property locations may not be related to Arlington facility emissions or releases because these compounds can be related to any combustion sources, such as wood burning, trash burning, or wildfires.

## **4.4 Background Soil Samples**

Twenty stations were sampled near the Arlington facility to establish background concentrations of COCs in soil. PCP was detected at five of the 20 background soil sample stations, at concentrations ranging from 0.0028 to 0.022 mg/kg. DROs were detected at 19 of 20 stations, at concentrations ranging from 5.3 to 110 mg/kg; these results are below the proposed cleanup levels. Low levels of PAHs were detected in most of the offsite samples. The highest concentration was observed more than 2 miles west of the facility, and this location was the only location where a PAH (chrysene) was detected at a concentration above the proposed cleanup level at the time of investigation. It is unlikely that the Arlington facility is the source of the elevated chrysene concentration 2 miles away, which likely would be related to some other facility or source near the sample location.

## **4.5 Ecological Conditions**

The Arlington facility property is developed and used solely for industrial operations. There are no areas at the facility that function as ecological habitats. Based on previous facility investigation data, no soil outside the facility property boundary has been affected by releases from the Arlington facility. Groundwater monitoring indicates PCP concentrations above cleanup levels extend approximately 420 feet downgradient of the facility boundary; however, this downgradient area does not include ecological habitat. Therefore, no conditions adverse to ecological risk have been identified for this CMS and onsite COC concentrations have not been compared to ecological screening levels.

## **4.6 Summary: Areas of Concern**

The primary area of concern is the subsurface soils in the Main Treatment Area of Parcel A, as shown in Figure 4-1. Vadose zone soils in this area are affected by COCs, residual LNAPL, and limited mobile LNAPL. Some of these affected soils are in contact with shallow groundwater. Those affected soils in contact with groundwater create a long-term source of groundwater contamination, which flows northwesterly toward the Northwest Parcel and the facility boundary.

Subsurface soils in the Treated Pole Storage Area also are affected by COCs. The measured COC concentrations in subsurface soils are below levels of concern for dermal contact, but exceed proposed soil cleanup levels. Groundwater beneath the Treated Pole Storage Area and the northwest parcel and downgradient areas are affected by the groundwater plume originating in the Main Treatment Area. The contribution of dissolved-phase constituents from subsurface soils beneath the Treated Pole Storage Area is relatively minor.

In Parcel B, the Untreated Pole Storage Area, only low levels of COCs are present in surface and shallow subsurface soils. Only one analyte (RRO) in one soil sample exceeded the applicable proposed cleanup level for soil. Groundwater monitoring wells in or near Parcel B (MW-4, MW-10, MW-14, BXS-3, BXS-4, and HC-MW-5) have not indicated the presence of any COCs above proposed cleanup levels. Because of the low levels of COCs in shallow soils (in isolated areas), and the lack of COC detections in groundwater, existing concentrations of COCs in Parcel B soils meet the WAC 173-340-747 empirical demonstration requirements for groundwater protection, and corrective measures therefore are not warranted.

## 5.0 Conceptual Site Model

This section presents the CSM for the Arlington facility based on a synthesis of the available physical and chemical data, historical operations compiled in the SI, and investigations conducted since completion of the SI. The CSM presents an understanding of the contaminant sources, distribution, and transport pathways based on the available data.

Figure 5-1 is a block diagram from the SI report visually depicting the CSM. The block diagram illustrates the current understanding of the potential sources and releases of COCs, generalized hydrogeologic information, and COC distribution and transport at the facility. The CSM block diagram is separated into three discrete blocks that generally relate to the Untreated Pole Storage Area, Main Treatment Area, and Treated Pole Storage Area.

### 5.1 Constituents of Concern

Based on the operational history and investigations at the Arlington facility, the following COCs have been identified:

- **Pentachlorophenol.** Petroleum-hydrocarbon-based PCP solution continues to be used at the facility to treat wood products. The PCP solution is primarily dry PCP dissolved in carrier oil. The PCP solution also contains TeCP and trichlorophenol (TCP). Breakdown products of PCP include TeCP, TCP, dichlorophenol (DCP), pentachloroanisole, and other phenolic compounds. Contaminants in technical-grade PCP include PCDDs/PCDFs.
- **Petroleum hydrocarbons.** Petroleum hydrocarbon mixtures (generally referred to as total petroleum hydrocarbons or diesel-range organics (DROs) have been used at the facility as carriers for PCP and/or creosote. The carrier historically used for PCP treating solutions is medium aromatic oil with physical characteristics similar to No. 2 diesel oil.
- **Polycyclic aromatic hydrocarbons.** PAH compounds are the main components in creosote mixtures and historically were used at the facility. Additional sources of PAHs may include the petroleum-hydrocarbon-based carrier for creosote and PCP treating solutions.

### 5.2 PCP/Creosote Use and Source Areas

Two main chemical use/process source areas have been identified for the Arlington facility based on facility operations and the known and potential contaminant source areas at the facility: the Main Treatment Area and the Treated Pole Storage Area (Figure 5-1).

### **5.2.1 Main Treatment Area**

The Main Treatment Area is where current and historical wood-treating processes and chemical use have occurred. All currently used treating equipment, including the two pressure retorts, new butt tank, and tank farms, is located within concrete secondary containment structures. No spills from these current operations have occurred, and annual inspection records at the facility indicate that these secondary containment structures remain in good structural condition. Known sources of releases in the Main Treatment Area are historical and are potentially associated with the old butt tank, old thermal tank, old thermal retort, and former drip area. Locations of these features are shown on Figure 4-2.

### **5.2.2 Treated Pole Storage Area**

The Treated Pole Storage Area surrounds the Main Treatment Area and is used to store treated poles. Known historical or potential sources of releases in the Treated Pole Storage Area include a former old butt tank spill accumulation area, stormwater ditches, and former catch basins.

## **5.3 Potential Air Emissions Sources**

Air emission sources include wood-treating operations in the retorts and butt tank, storage and handling of wood-treating solutions, recycling of wood-treating chemicals, treated water recycling and cooling tower operation, and fugitive emissions from process piping. However, the major COCs used at the facility (e.g., PCP) are not considered volatile organic compounds and do not readily volatilize. Therefore, corrective measures for potential air emissions are not considered in this CMS.

## **5.4 Transport Pathways**

Potential pathways identified in the SI for COC transport to human or ecological receptors include air transport and direct contact with soil, groundwater, LNAPL, and stormwater. Of these, direct contact with subsurface soil, groundwater migration, and LNAPL pathways were considered and evaluated in the SI as having a potential for ongoing effects on human receptors. The potential ongoing exposure pathways and receptors are depicted in Figure 5-2.

### **5.4.1 Direct Contact Pathways for Soil**

Direct contact with surface soil is not a pathway of concern, as COC concentrations at the surface are below industrial RSLs, as defined in Section 3.2. Ditch sediments and stormwater have been eliminated as media of concern because of constructed improvements at the facility. These improvements include excavation and disposal of ditch sediments, and construction of drip pad

aprons, berms, and the stormwater treatment system. Potential exposure to subsurface soil remains a potential pathway in a trench worker scenario.

#### **5.4.2 Groundwater and LNAPL Pathways**

The groundwater and LNAPL pathways involve the movement of a COC (such as PCP or PAHs) in groundwater to potential downgradient receptors. To be considered a complete pathway, the COC must be incorporated into groundwater (1) in a dissolved (aqueous) phase, (2) sorbed onto particulate or colloidal particles, or (3) as LNAPL, and the COC must be transported to a point of contact with the end receptor (human or ecological). At the Arlington facility, groundwater transport of COCs may occur by the following mechanisms:

- Leaching of COC-affected soils or sediments in the vadose (unsaturated) zone and infiltration of the leachate to groundwater
- Direct contact of COC-affected soils with groundwater
- Direct contact of LNAPL (containing COCs) with groundwater
- Migration of affected groundwater
- Migration of LNAPL

Historically, all these processes may have occurred at the facility. Based on results of the SI, groundwater is in contact with LNAPL and with soil affected by COCs in the Main Treatment Area, and a dissolved-phase plume is present beneath the facility. However, the exposure currently is limited because of the lack of nearby receptors hydraulically downgradient of the facility. The closest downgradient residence that currently uses groundwater from a private well is located approximately 4,000 feet northwest of the facility. All residents and businesses in this area have access to the City of Arlington's water system.

#### **5.4.3 Air Transport Pathways**

The potential pathways for emissions from wood-treating operations at the Arlington facility include potential direct exposure to airborne vapors and potential deposition of vapors onto the ground. Deposition could occur both on and off the facility property. PCP then could accumulate in surface soils, where direct contact could occur or the chemicals could migrate from surface soil into surface water or groundwater. The potential for inhalation by onsite workers was eliminated from consideration in the SI based on industrial hygiene testing that documented airborne concentrations of COCs only a small fraction of the allowable Occupational Safety and Health Administration workplace limits. Inhalation by nearby residents also was shown to be below risk-based screening levels by modeling air data. The air transport pathway is not a pathway requiring or considered for corrective action, as discussed in Section 4.3.

## **5.5 Potential Receptors**

Potential receptors for exposure pathways include onsite workers and nearby residents.

### **5.5.1 Onsite Workers**

Current and future onsite workers have the potential to contact surface and subsurface soil in the Main Treatment Area. Surface soil COC concentrations have been shown to be below risk-based industrial exposure levels. However, there is a possibility that a current or future onsite worker doing subsurface utility or construction work could come into contact with subsurface soil COCs above risk based industrial exposure levels. Typically, such workers at an industrial facility would use appropriate personal protective equipment (PPE) to avoid any adverse exposures; however, longer-term corrective measures will need to be considered in development of alternatives to address this risk.

Groundwater containing COCs is present at depths greater than 10 to 15 feet bgs in the Main Treatment Area at the Arlington facility. This depth is in the upper end of the depth range for workers doing subsurface utility or construction work. Therefore, it is not reasonable to consider potential worker exposure to groundwater in developing corrective measures in this CMS.

### **5.5.2 Nearby Residents**

Onsite residential receptor exposure would occur only in the unlikely hypothetical future scenario that the facility is closed and redeveloped for residential use or if drinking water wells were installed at the facility. Existing land use zoning and ongoing industrial use at the facility eliminate these onsite receptors under current conditions; however, ICs will need to be implemented as part of any final corrective measure so that this risk is properly addressed.

The facility is an “industrial property” under WAC 173-340-200. Such property that is zoned for industrial use need not consider hypothetical future residential uses, and both site evaluations and remedial actions can be based on industrial pathways as the reasonable maximum exposure assuming that ICs will be part of the corrective measure. Corrective actions are considered by the EPA to be “complete without controls” only when the site meets all applicable cleanup levels, including residential. If corrective action is completed, but residential cleanup levels cannot be met, restrictions or ICs may need to be placed on the site. Under this scenario, EPA would consider the site “corrective action complete with controls.”

Although affected groundwater extends from the facility property, the leading edge of the plume remains approximately 3,600 feet from the nearest private drinking water well. The distance of the plume from the source area in the Main Treatment Area was considered to be at steady state prior

to installation of the pilot study recirculation system. At that time, the leading edge of the plume was approximately 3,600 feet from the nearest private drinking water well. With the success of the recirculation system, the plume will continue to shrink downgradient of the system. Nearby residential receptor exposure would be associated only with potential migration of constituents by groundwater migration to hydraulically downgradient private wells. Given the distance from the leading edge of the plume, stability of the plume in absence of treatment, PCP concentrations in groundwater are not expected to reach downgradient private wells. Since residential receptors do not have the potential to be affected by facility releases, no corrective measure is anticipated for the residential groundwater pathway.

Surface soil has been tested at locations beyond the facility boundary and shown to have no concentrations of facility-related constituents above residential risk-based screening levels.

Ambient air at the facility has been modeled based on onsite air quality and compared to risk-based screening levels (PRGs - Ambient Air). The air quality models show that air from the facility poses no risk of adverse effects to downwind residents.

## **6.0 Corrective Measures Considerations**

Unique conditions associated with the Arlington facility require consideration when developing and selecting a final corrective measure. The AOC also specifies several factors that must be evaluated during the technology screening process. These considerations include site conditions, operational conditions, contaminant characteristics, technology limitations, and regulatory issues, as discussed in the following subsections.

### **6.1 Site Conditions**

The portions of the Arlington facility that require corrective action are Parcel A, Parcel B, groundwater underlying the Northwest Parcel, and affected groundwater extending downgradient from the Northwest Parcel (Figure 2-2). The Closed Woodwaste Landfill does not need to be addressed by further corrective action because it has been formally closed through the Snohomish County Health District. The Northwest Parcel and downgradient areas with affected groundwater have had no facility operations, but concentrations of PCP in groundwater exceed the proposed cleanup level as a result of releases from Parcel A. As such, corrective measures developed for the facility in the following sections will address affected groundwater that extends downgradient from the Main Treatment Area, including areas outside the Baxter property.

### **6.2 Operational Conditions**

Parcel A encompasses the main industrial operations for the facility (Figure 2-2). It has served as the wood-treatment area since the middle to late 1960s before Baxter's purchase of the wood-treating operations. COC-affected soils within the Main Treatment Area are the primary source of COCs in groundwater at the Arlington facility and include an area of LNAPL. However, because this area is the hub of the Arlington facility operations, any technologies proposed to address soils affected with COCs in the area must also consider the effects of the remedial activities on facility operations and the facility operation's effects on the remedial activities.

As stated in Section 2.5, Stella-Jones owns and operates the treatment facility. Baxter retains ownership of the real property and receives lease payments from Stella-Jones under a long-term agreement. The lease payments fund the ability to perform the remedy. Interruption of operations may give Stella-Jones a claim that it has cause for lease termination. Baxter performs all remediation work related to the AOC. Any extended cleanup period or construction will affect the tenant's ability to manufacture treated wood products, resulting in decreased revenue to the tenant and potential opportunity losses, which could include long-term loss of customers. These factors could result in a breach of contract and loss of the tenant and lease revenue to Baxter. In addition, any corrective measure planned in the area of the facility operations could be affected by the

current operations. For example, operational constraints may preclude placing components of the remedy in the ideal locations. Evaluation of the proposed corrective measure alternatives will need to consider these effects.

This parcel is expected to remain industrial for the foreseeable future. The facility is zoned Industrial and meets the MTCA definition of an industrial property.

Parcel B, the Untreated Pole Storage Area, has had a less intense industrial use (Figure 2-2). Parcel B includes an area for untreated pole storage, a lunch room, a storage building, an incisor, a framing building, the pole peeler, and the stormwater treatment system and infiltration gallery. Parcel B was not purchased by Baxter until 1970 and has been used predominantly for industrial activities that have not involved handling hazardous materials. While the SI found soil in several locations within Parcel B with COC concentrations that exceeded proposed soil cleanup levels based on direct residential exposure (see Appendix A); none of the COCs in Parcel B exceeds direct exposure cleanup criteria in an industrial setting. Because the property is zoned Industrial and meets the MTCA criteria as an industrial site, corrective measures other than possible deed restrictions may not be necessary. Placement of a deed restriction on Parcel B would result in a RCRA designation of "Corrective Action Complete with Controls."

## **6.3 Contaminant Characteristics**

The primary area of affected soil and groundwater is located in Parcel A. Affected soil is confined largely to the Main Treatment Area, which also contains an area of residual LNAPL.

### **6.3.1 Soil and LNAPL**

LNAPL has been observed in soil samples collected from borings ranging in depth from 10 to 42 feet. At time of installation, LNAPL was observed within three existing monitoring wells (MW-12, MW-13, and MW-19) (Figure 4-2). Most of the residual LNAPL observed in these boreholes was present within the vadose zone soils and had not migrated to groundwater. Both EPA and MTCA regulations and guidance documents list source treatment or removal as a preferred corrective measure. The area containing LNAPL is considered the primary source affecting groundwater; however, the nature of the LNAPL underlying the Main Treatment Area presents challenges to removal. Pilot testing indicates that limited amounts of mobile LNAPL can be recovered by passive extraction (i.e., bailing or absorbent socks), but several weeks or months are required before LNAPL thickness returns to pre-extraction thicknesses. It is not known why the residual LNAPL in the vadose zone has not migrated downward. It could result from differences in viscosity (i.e., high viscosity LNAPLs are preferentially held in vadose zone soils because of greater capillary forces), or because the volume is below the residual saturation levels. The residual LNAPL, which is present over a large area and at varying depths, is recoverable only through invasive and

disruptive remediation technologies, such as thermal or chemical processes (e.g., electrical resistance heating, steam injection, or chemical oxidation) or excavation.

Any potential excavation within the Main Treatment Area would carry significant cost including the potential need to shut down at least a portion of the facility. Other alternatives, such as thermal treatment or chemical oxidation, could be implemented at the facility during operations, although at a higher cost.

Treatment or removal of LNAPL associated with wood-treating operations has proven difficult, especially when the NAPL is present at or below residual saturation levels (Cheremisinoff and Rosenfeld, 2010). The viscosity of LNAPL associated with wood-treating compounds varies greatly, from tar-like material that has low mobility to less viscous material that could be more prone to migrate. Pure creosote tends to behave as a dense NAPL (DNAPL), but the PCP/Carrier Oil mixtures behave as LNAPL. A common remediation approach used to limit LNAPL and DNAPL migration at wood-treating sites includes containment technologies, thermal treatment, and chemical oxidation (EPA, 1992).

At the Arlington facility, the presence of diesel-based LNAPL on the water table and residual LNAPL in the vadose zone beneath an active production facility (i.e., the Main Treatment Area), combined with the presence of woodwaste in the subsurface, will limit the effectiveness and implementability of available technologies. This situation needs to be considered in the development of the alternatives.

In addition, COC-affected soil excavated from Parcel A would be classified as a RCRA-listed waste, and therefore would have high disposal costs. High disposal costs need to be evaluated against the benefit gained by potentially eliminating a source area.

### **6.3.2 Groundwater**

The existing groundwater plume beneath the Arlington facility extends northwesterly from the source area under the Main Treatment Area to the Northwest Parcel and to areas immediately downgradient of the Northwest Parcel. PCP is the primary COC within the plume, with PAH compounds also present in groundwater near the source area (Figure 4-1). The presence of PCP in the groundwater creates regulatory considerations in evaluating technologies. Any water generated by a technology, such as pumping or aboveground treatment, potentially would be considered a RCRA-listed waste because of the presence of PCP. RCRA has an exemption from this waste listing if the water is discharged to a publicly owned treatment works (POTW), such as the POTW operated by the City of Arlington. Other options for disposal of treated groundwater include infiltration into the ground or discharge to the ditch located on the eastern margin of the Arlington facility. Extracted groundwater reinjected into the groundwater plume is exempted from

the RCRA-listed waste issue, and the reinjection can be done under a Class V injection permit available through Ecology. Discharge of treated groundwater to the ditch would require a discharge permit and permission from BNSF, the owner of the ditch.

## **6.4 Technology Limitations**

The subsections above outline specific factors to be considered for remedy selection based on site conditions and contaminant characteristics. In addition, for the types of COCs at the Arlington facility, technologies are limited in their application. Both EPA guidance and MTCA guidance have a preference for COC destruction or removal for both the source area and any associated plume. For wood-treating sites, the characteristics of the COCs are such that complete removal or destruction is unlikely even using aggressive remediation technologies.

## **6.5 Regulatory Considerations**

EPA guidance (EPA, 1996) and policy require source areas to be addressed by permanent solutions to the extent practicable. The MTCA regulations (WAC 173-340-360), which are applicable to this facility, also prefer permanent solutions. Both EPA and Ecology have a common goal: to eliminate the potential risk that a hazardous substance can remobilize in the future if a nonpermanent remedy fails. However, both EPA and Ecology recognize that permanent solutions are not always practical and allow exceptions to the goal of a permanent solution.

## **7.0 Corrective Measures Objectives**

Corrective measure objectives (CMO) are developed in this section as an initial step in the development of corrective measures for this facility. CMOs define the locations, media, constituents, and receptors that need to be addressed by the selected corrective measures to remediate potential adverse risks. The qualitative objectives are summarized in this section. Corrective measures are needed only to address potential human health risks because no ecological habitats could be impacted by affected groundwater (see Section 4.5).

As agreed by Baxter and EPA, no site-specific quantitative risk assessment needs to be conducted for this facility. Although EPA will determine final cleanup levels, media-specific concentrations will be compared to risk-based screening levels, the proposed cleanup levels developed in Section 3, and corrective measure considerations discussed in Section 6 to identify areas where corrective actions are warranted.

### **7.1 Applicable Requirements**

The potentially applicable federal laws that will be considered for potential corrective actions and proposed cleanup levels include:

- Clean Water Act (including the National Toxics Rule and NPDES requirements)
- Safe Drinking Water Act (including Drinking Water Standards and Health Advisories)
- RCRA
- Toxic Substances Control Act
- EPA RSLs

Potentially applicable state laws and regulations include:

- Water Resources Act of 1971
- Drinking Water Act (including Drinking Water Regulations)
- Hazardous Waste Management Act (including Dangerous Waste Regulations)
- MTCA

### **7.2 Corrective Measures Objectives**

The requirements for CMOs are set forth in the AOC (EPA, 2001) and EPA guidance documents (EPA, 1994 and 1996). General CMOs for designated areas and media at the facility are developed in this section and will be discussed for each medium in the following subsections.

### **7.2.1 Subsurface Soil**

COCs are present in subsurface soil in the Main Treatment Area as a result of the historical release of wood-treating chemicals. Concerns at the facility include soil concentrations of COCs above proposed cleanup levels and residual LNAPL retained in the vadose zone by capillary forces.

The CMOs for subsurface soil are to:

- Reduce COC concentrations to cleanup levels within a reasonable time frame.
- Prevent exposure to adverse concentrations of soil COCs by future onsite workers doing subsurface work via direct contact, ingestion, or inhalation.
- Prevent or minimize the potential for adverse leaching of soil COCs to groundwater.

### **7.2.2 LNAPL**

Mobile LNAPL is present in a very limited area of the facility within the Main Treatment Area. The CMO for mobile and residual LNAPL is to:

- Reduce the mass and area of leachable residual LNAPL and mobile LNAPL present in the subsurface to minimize the potential for COCs to leach from the LNAPL into groundwater.

### **7.2.3 Groundwater**

Affected groundwater currently occurs under the Main Treatment Area, Treated Pole Storage Area, and Northwest Parcel. Affected groundwater also is present in areas immediately downgradient of the Northwest Parcel. Mann-Kendall plots generated with monitoring data collected during the SI indicated that the PCP plume was stable; however, the plume area has decreased since implementation of the Pilot Study (see Section 9.2.4). Groundwater beneath the facility currently is not used for drinking water, but as a conservative measure, the overall CMO for groundwater is to prevent any adverse future human or ecological exposure to affected groundwater. The specific CMOs for groundwater are to:

- Prevent future use of groundwater beneath the facility for drinking water.
- Reduce COC concentrations in groundwater to below drinking water standards within a reasonable time frame.
- Prevent downgradient migration of groundwater with COC concentrations above drinking water cleanup standards.
- Minimize the mass and area of contaminants in affected groundwater over time.

### **7.3 Overall Objectives**

In summary, the CMOs for the Arlington facility address subsurface soil at the facility and groundwater beneath the facility. The CMOs are to:

- Prevent human exposure to subsurface soil containing COC concentrations above industrial cleanup levels.
- Prevent or minimize the migration of adverse concentrations of COCs from soil to groundwater.
- Prevent human exposure to groundwater COC concentrations above drinking water standards.
- Prevent migration of COCs in groundwater.
- Minimize the contaminant mass and area in subsurface soil, LNAPL, and groundwater.
- Minimize concentrations of COCs in soil and groundwater to achieve cleanup levels and protect human health and the environment.

## 8.0 Technology Screening

In this section, technologies that potentially may be used to address conditions at the facility will be identified and screened on the basis of their applicability to the specific site conditions and COCs at the Arlington facility. Technology screening is a coarse assessment, with two possible results:

(1) the technology is potentially suitable to site conditions and therefore was retained for further consideration; or (2) the technology is not appropriate or feasible for this facility and therefore was not retained.

### 8.1 General Response Actions

General response actions are medium-specific actions that will satisfy the CMOs. General response actions may include treatment, containment, excavation, extraction, disposal, ICs, or a combination of these. General response actions considered for satisfying CMOs at the Arlington facility are summarized below.

#### 8.1.1 Subsurface Soil

General response actions for subsurface soil in the Main Treatment Area include:

- Monitored natural attenuation (MNA)
- ICs
- Containment
- Recovery/removal
- Ex situ treatment
- In situ treatment

MNA is a general response action that relies on natural attenuation mechanisms to reduce contaminant concentrations to corrective measures goals. No efforts would be taken under this general response to remove, treat, or otherwise control the release of contaminants in the subsurface.

ICs are administrative measures undertaken to limit or prohibit activities that may interfere with a cleanup action or result in exposure to hazardous substances. They typically include legal restrictions, such as use limitations recorded on the property deed.

Containment technologies include the use of engineered barriers to isolate wastes. When properly constructed and maintained, these barriers often provide a reliable means of minimizing direct

exposure and controlling the spread of contaminants from a waste source. Containment technologies include both horizontal (e.g., caps) and vertical (e.g., slurry wall) barriers.

Recovery/removal refers to the physical removal of wastes from the subsurface. The most common recovery/removal response action for contaminated soil is excavation. Shallow soil typically is easy to excavate, and deeper soils may be removed with appropriate equipment or by using terraced excavations.

Ex situ treatment involves the excavation of contaminated soil and subsequent offsite treatment or direct landfill disposal without treatment.

In situ treatment treats contaminated soils in place without excavation. In situ treatment technologies for soil typically use some form of chemical and/or physical process to reduce contaminant concentrations, or otherwise render contaminants immobile.

### **8.1.2 LNAPL**

General response actions for LNAPL within the Main Treatment Area include:

- MNA
- ICs
- Containment
- Recovery/removal
- Ex situ treatment
- In situ treatment

MNA, ICs, and containment response actions would be the same as described in Section 8.1.1. General response actions for recovery/removal of LNAPL include the use of bailers, skimmers, or pumps to recover and remove LNAPL from the subsurface, plus in situ treatment options, such as thermal and chemical processes, and biological processes. Ex situ treatment for LNAPL typically involves the physical separation of LNAPL from groundwater and subsequent offsite disposal via incineration.

### **8.1.3 Groundwater**

General response actions for groundwater include the following:

- MNA
- ICs

- Containment
- Recovery/removal
- Ex situ treatment
- In situ treatment

MNA, ICs, and containment response actions would be the same as described in Section 8.1.1. General response actions for recovery/removal of groundwater include the use of pumps to recover contaminated groundwater from the subsurface.

Ex situ treatment for contaminated groundwater typically involves the removal and/or destruction of contaminants via physical or chemical processes. Once treated, the water would be disposed of either onsite (e.g., direct discharge to ground surface) or offsite (e.g., discharge to a POTW).

In situ treatment technologies for contaminated groundwater typically use some form of chemical, physical, or biological processes to reduce contaminant concentrations, or otherwise destroy contaminant mass.

## **8.2 Potentially Applicable Technologies**

A range of proven and innovative technologies has been considered to identify those that have potential applicability to subsurface soil and groundwater at the Arlington facility. Available technologies include ICs, engineering controls, and in situ and ex situ remediation technologies. This section describes the results of technology screening and identifies which technologies were retained.

Technology screening begins by identifying potentially applicable technologies. Retained technologies for each affected medium (subsurface soil, LNAPL, and groundwater) are evaluated relative to one another on the basis of three criteria:

- **Effectiveness.** This criterion evaluates the technology for its protectiveness and reduction in contaminant toxicity, mobility, or volume. Both short-term and long-term effectiveness are evaluated. Short-term effectiveness addresses the construction and implementation periods. Long-term effectiveness evaluates the technology after the corrective action is in place.
- **Implementability.** This criterion evaluates the technology for technical and administrative feasibility. Technical feasibility refers to the ability to construct, operate, maintain, and monitor the action during and after construction and meet technology-specific regulations during construction. Administrative feasibility includes factors such as the ability to obtain

permits for offsite actions and the availability of specific equipment and technical specialists.

- **Cost.** This criterion represents the relative costs of different technologies so that the technologies can be compared in relative terms to each other. Typically, the full cost of a given technology cannot be determined at this screening level; however, knowledge of typical technology costs obtained from vendors, cost-estimating guides, EPA guidance documents, prior projects, and engineering judgment are used to determine the relative cost of a technology compared with similar technologies.

The evaluation of applicable remedial technologies for each medium is described below for subsurface soil, LNAPL, and groundwater. Some technologies are classified under multiple media, and may be screened differently depending on the intended use.

Technologies that pass the screening evaluation are assembled into corrective measures alternatives, which are described in Section 9 and evaluated in Section 10. Alternate process alternatives ultimately may be selected for a cleanup action during the corrective measures design phase, based on design-level evaluation of similar options. Promising technologies for which design-level details need to be developed to fully evaluate their applicability are retained here, but subject to contingencies, such as interim remedial pilot-scale testing.

### **8.2.1 Technologies for All Media: Institutional Controls**

Potentially applicable ICs include:

- Deed restrictions addressing land use and soil excavation
- Deed restrictions to preclude drinking water use
- Use restrictions and monitoring requirements to prevent disturbance of caps or other engineered controls
- Public awareness and communication

ICs have the potential to address several residential and onsite worker exposure-related corrective measures objectives at the facility. A soil management plan requiring the use of PPE during any subsurface soil excavation work can reliably prevent worker exposure to subsurface soil contaminants and shallow groundwater. A deed restriction also can be applied to the property to prevent any future residential uses of the property, to prohibit onsite groundwater from being used for drinking, and to require a soil management plan with PPE during soil excavations. ICs to protect against exposure to affected downgradient groundwater could be implemented through public awareness and communication. Controls, such as management plans and deed restrictions, are proven and reliable and were retained for detailed evaluation.

## **8.2.2 Technologies for Subsurface Soil**

Technologies for subsurface soil include both in situ and ex situ technologies, as well as soil removal. Each of the technologies screened is described below.

### **8.2.2.1 Thermal Treatment**

Thermal treatment is a remediation technology that accelerates the removal of organic compounds from the subsurface, including LNAPL, soil contamination, and dissolved-phase contamination in groundwater. Steam or electrical energy is applied into the contaminated zone, and heat energy volatilizes contaminants into the vapor phase and dissolves contaminants into the groundwater. Groundwater extraction and treatment and dual-phase extraction technologies are required to remove and handle the contaminants that are removed from within the LNAPL and groundwater.

This technique was developed primarily to address NAPL or sites with volatile organic compounds, and has been successfully applied at several sites. A significant concern associated with this technique is that contaminants currently immobilized by capillary forces (e.g., residual LNAPL in the vadose zone) are mobilized by this technology (by increasing solubility). The risk for this technology is that it has the potential to significantly mobilize and further spread contamination.

The thermal treatment technology most applicable for the Arlington site is electric resistance heating (ERH). ERH is an in situ remediation technology that enhances recovery of soils contaminated with volatile and semivolatile organic compounds by applying electricity to heat the soil. ERH can simultaneously treat solvents found in saturated and unsaturated soil, groundwater, and pools below the groundwater table. Developed by the U.S. Department of Energy, ERH takes electricity from standard utility lines and applies it across electrodes placed in a grid pattern across an impacted site. As the subsurface resists the application of electricity, it is heated to the boiling point of water, producing steam and contaminant vapors. ERH can be applied from the subsurface to depths of 100 feet below grade. Heating the soil volatilizes contaminants, which are recovered by a total fluids recovery well and treated ex situ or recycled to the electrodes as wetting water. Each electrode can be constructed to function as a total fluid and vapor recovery well capable of recovering groundwater, LNAPL, steam, and contaminant vapors from the subsurface. With proper engineering controls, ERH can be safely used under roads, parking lots, and occupied buildings without the disruption of traffic or occupancy.

There are two main types of ERH: three-phase and six-phase. Three-phase heating consists of electrodes placed in a repeating triangular pattern where electricity is conducted between adjacent electrodes. Six-phase heating involves a hexagonal pattern of six electrodes with a neutral electrode placed in the center.

This technology will require close coordination with the current operator to minimize plant downtime. It is expected that installation would occur during evenings and weekends; however, there may be a need for a partial plant shutdown to install system components.

In general, this technology is most effective on fuel hydrocarbons, chlorinated solvents, and PAHs such as creosote and coal tar. ERH can be applied in all soil types, from clay to silt and from gravel to sand. Woodwaste in the subsurface at the Site could represent a challenge for ERH. ERH was retained for further consideration.

#### **8.2.2.2 Excavation and Offsite Disposal**

Excavation and offsite disposal of contaminated soil is a traditional heavy construction technique for removing contaminated soil from a site and disposing of it in an appropriately permitted landfill, thereby eliminating the potential for onsite worker exposures and future leaching of soil constituents to groundwater. This technique is best suited to small areas of shallow soil in readily accessible areas.

At the Arlington facility, the application of this technique is limited by the physical constraints of the ongoing facility operations and facility structures that overlay much of the affected soils in the Main Treatment Area. For this approach to be implemented, much of the main facility operational system (retort, drip pads, sumps, and tankage) would require either temporary or permanent relocation, and revenue-generating operations likely would cease for several months. This approach is further limited by accessibility constraints imposed by the depths of soil contamination (which in some areas has been detected at upward of 30 to 40 feet bgs), the presence of affected soils below the water table, and the presence of structures. These site-specific conditions make complete soil excavation impractical at the Arlington facility. The presence of permanent structures makes the likelihood of removing all of the affected vadose-zone soils unlikely. In addition, soils excavated from the Main Treatment Area may be subject to land disposal restrictions. Despite these limitations, this traditional basic technology was retained for further consideration because this technology would address all of the COCs in soil.

#### **8.2.2.3 Soil Stabilization**

This technology involves processes that react with the soil or contaminant to stabilize contaminants in the affected soil and reduce their leaching and migration potential. Stabilization methods include both in situ and ex situ techniques using materials such as Portland cement, asphalt, lime, polymers, resins, chemical oxidants, and sorbents to modify the physical and/or chemical properties of soil. Ex situ stabilization requires excavation of the soil to be treated. In situ treatment requires substantial disturbance to the soil to mix stabilization agents into the soil. These processes typically result in expansion of the soil volume because of the amount of material added and chemical reactions; the range of volume expansion typically encountered with this technology

is in the range of 10 to 25 percent. This technology has been most successful for metals; however, some success has been achieved in stabilizing organic contaminants at other wood-treating facilities.

The size and depth of the affected area at the site, some of which is below the water table, and access constraints imposed by the ongoing operations at the facility reduce the applicability of both in situ and ex situ stabilization. Because of the depth of site contamination, volume expansion would substantially modify the site elevation, requiring either offsite disposal or site redevelopment. Soil stabilization was retained for further consideration.

#### **8.2.2.4 Chemical Oxidation**

Chemical oxidants have been able to cause the rapid and complete chemical destruction of many toxic organic chemicals, and other organics are amenable to partial degradation as an aid to subsequent bioremediation. Reduction/oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. Redox reactions involve the transfer of electrons from one compound to another. Specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons). The oxidizing agents most commonly used are ozone, hydrogen peroxide, permanganate, hypochlorite, chlorine, and chlorine dioxide, and the most common application is in situ versus ex situ.

In general, the oxidants have been shown to be capable of achieving high treatment efficiencies for chlorinated ethenes (e.g., trichloroethene) and saturated aromatic compounds (e.g., benzene), but use on semivolatile organic compounds (e.g., PAHs) or highly chlorinated aromatic organics (e.g., PCP) is not as common. Field applications have clearly shown that matching the oxidant and in situ delivery system specifically to the COCs and the site conditions is the key to successful implementation and achieving performance goals. The presence of LNAPL would require multiple applications and high volumes of reagents. The handling of large quantities of strong oxidizers is also a disadvantage of this method. However, several newer oxidation products provide safer handling as a result of using a two-part mixture to release oxidants (rather than using oxidant in its pure form).

Where woodwaste backfill and COCs overlap, oxidants would be at best ineffectual and at worst a fire hazard (depending on the strength of oxidant used, presence of LNAPL, and moisture content of the woodwaste).

In general, this technique is most cost effective on dissolved-phase constituents, rather than LNAPL and COC-affected soils because of the commensurately larger volumes of reagents and reduced soil permeability associated with LNAPL zones. This technology is a potentially effective alternative, and was retained for limited use for subsurface soil. In follow-up to the feasibility of the

in situ oxidation, a bench-scale treatability study was conducted in 2013 (Baxter, 2014f), the results of which are included in Appendix H.

#### **8.2.2.5 Enhanced Bioremediation**

Enhanced bioremediation is a process in which indigenous or inoculated microorganisms (e.g., fungi, bacteria, or other microbes) degrade (metabolize) organic contaminants found in soil and/or groundwater, converting them to innocuous end products. For source area applications, the energy source is present (NAPL) and microbial activity is limited by the lack of electron acceptors (e.g. oxygen and nitrate) or nutrients (e.g. nitrogen and phosphorus). Enhanced bioremediation stimulates the activity of naturally occurring microbes by circulating growth-stimulating solutions through contaminated soils to enhance in situ biological degradation of organic contaminants. An in situ bioremediation system could include injecting amendments directly into the soil or extracting source area groundwater, mixing with bioremediation amendments, then injecting back into the vadose zone within the source area. Findings from the biodegradation bench study (Appendix H) indicate that this technology is suitable at this Site. This technology is potentially applicable at the Main Treatment Area and was retained for further evaluation.

### **8.2.3 Technologies for LNAPL**

LNAPL can be removed from the subsurface by pumping fluids from wells or trenches. LNAPL recovered from wells (by various technologies, such as pumping or passive flow) or trenches can be recovered as a “pure-phase,” or recovered with groundwater followed by subsequent separation in aboveground facilities. Alternative methods of LNAPL removal include steam or co-solvent enhanced extraction, which is intended to mobilize COCs into the dissolved phase then recapture those mobilized COCs through a groundwater extraction system. Depending on the nature of the contamination and/or the source of the release, LNAPL and/or groundwater collected by liquid pumping or separated from other waste materials may be classified as a hazardous waste, and could require a RCRA permit for treatment. Options for management of recovered LNAPL include recycling and/or incineration.

#### **8.2.3.1 Total Fluids (Dual-Phase) Recovery**

Total fluids recovery, also known as multi-phase extraction, includes the recovery of groundwater and mobile LNAPL using extraction wells and then separation, treatment, and disposal of the extracted fluids. Typically, this technique involves the installation of recovery wells in the LNAPL area with screens placed across the top of the water table and overlying LNAPL zone. Well pumping pulls in groundwater and mobile LNAPL that flow into the well. Groundwater extraction typically creates a cone of depression in the water table that can facilitate LNAPL collection by encouraging increased flow of LNAPL to the recovery well along the depressed slope of the water table surface. Care must be taken in the placement of the well screen depths so as not to cause LNAPL smearing across a greater zone while still using the cone of depression to advantage.

Phase separation and groundwater treatment of recovery fluids are required. Water generated and treated can be disposed of either through discharge to a POTW or reinjection into the existing groundwater plume. This technology is potentially applicable at the Main Treatment Area and was retained for further consideration.

#### **8.2.3.2 Thermal Treatment**

Steam enhanced extraction and ERH are included in thermal treatment. Steam-enhanced extraction uses steam injection to vaporize organic contaminants in LNAPL so they can be more readily collected in extraction wells. For the Arlington facility, ERH has been selected as a representative thermal treatment system that can be adapted to the Arlington facility, as discussed in technologies for soil. ERH was retained as a thermal technology.

#### **8.2.3.3 Co-Solvent-Enhanced Extraction**

In situ co-solvent extraction involves flushing fluids containing water-miscible co-solvents through contaminated soil to facilitate the removal of contaminants by enhanced LNAPL dissolution and/or mobilization and enhanced desorption. These co-solvents achieve LNAPL removal through several complementary mechanisms, including (1) reduction of interfacial tension between the aqueous and LNAPL phases; (2) enhanced solubility of the LNAPL components in the aqueous phase; (3) swelling of the LNAPL phase relative to the aqueous phase; and (4) under certain conditions, complete miscibility of the aqueous and LNAPL phases. Various co-solvents can preferentially partition into the LNAPL or aqueous phase. Co-solvent enhanced extraction uses co-solvent injection to mobilize contaminants so they can be more readily collected in total fluids recovery wells for onsite treatment and/or disposal. A significant concern associated with this technique is that contaminants currently immobilized by capillary forces (e.g., residual LNAPL in the vadose zone) are mobilized by this technology (by increasing solubility). Unless groundwater recovery at a downgradient location is completely effective, the technology can significantly mobilize and further spread contamination. Given the relatively rapid groundwater flow rate in the sand and gravel aquifers underlying the affected area, and the relatively small dissolved-phase plume, other technologies are more suitable for the Arlington facility. For these reasons, this technology was not retained for further consideration.

#### **8.2.3.4 Passive Recovery**

Passive recovery involves collection of LNAPL that passively flows into wells (either existing monitoring wells or specifically designed recovery wells) using bailers, sorbent socks, oil skimmers, or skimming pumps. This method relies on the gradual natural movement of LNAPL into wells without enhancement. LNAPL movement into wells is driven by the gradient created by reduced LNAPL levels in the well casings, maintained by repetitive removal of LNAPL from the wells, versus levels in the formation. The selection of the appropriate technology between different individual technologies (e.g., skimmers versus sorbent socks) is based on the amount of LNAPL present, the

viscosity, the specific gravity, and operational issues, such as necessary treatment. At the facility, the flow of LNAPL into wells has been observed to be extremely slow, which suggests that passive LNAPL recovery approaches, such as sorbent socks, may be more appropriate than active recovery approaches using skimmers or skimming pumps. Skimmers or skimming pumps could be effective if LNAPL volumes are found to be high and LNAPL readily flows to the recovery wells. At low recovery rates, passive sorbent materials or bailers would be more cost effective than active LNAPL recovery options. This technology has been implemented for over 10 years in the Source Area at the Site. Recovery of NAPL has been about 10 gallons over a 10 year period. Though recovery rates have been low, this technology continues to be potentially applicable at the Main Treatment Area and was retained for further consideration.

#### **8.2.3.5 *Interceptor Trench***

Extraction of LNAPL—including collection using bailers, sorbent socks, skimmers, or pumps—also can be accomplished from interceptor trenches instead of wells. This method can enhance LNAPL collection by intersecting downgradient LNAPL migration at proportionally larger subsurface areas (trench area versus monitoring well circumference). This method relies on the natural movement of LNAPL into the interceptor trench without enhancement, and typically is applied to sites with migrating LNAPL. This method is not applicable at the Arlington facility because no evidence exists for migrating LNAPL. Installation of a trench would be costly, and likely would not be effective at LNAPL removal. For these reasons, this technology was not retained for further consideration.

#### **8.2.3.6 *Chemical Oxidation***

Although not ideal for NAPL removal because of high chemical costs and potential hazards as discussed above, if carefully applied this method can be effective and would preclude management of recovered LNAPL. Careful selection of oxidant and use in a targeted manner are required to minimize hazards and costs. Chemical oxidation bench studies in 2014 (Appendix H) for source area soils demonstrated the viability of this technology. Chemical oxidation was retained for further consideration.

#### **8.2.3.7 *Management of Recovered LNAPL***

LNAPL collected from liquid pumping or separated from other waste materials may be classified as a hazardous waste. Disposal options for LNAPL include:

- **Recycling/Reuse.** If available, recycling of recovered LNAPL at a wood-treating facility is the preferred and lowest cost method of disposal, but may not be practicable because of the potential for hazardous waste classification and the low demand for this product. The low demand for the recovered product from the Arlington facility results from the presence of contaminants in the LNAPL from other historical wood-treating products, and the stringent specifications required by the American Wood Preserving Institute during the

manufacturing process used by virtually all treating facilities. This management option was not retained because Baxter has not found a suitable recycling facility.

- **Incineration.** Recovered LNAPL is anticipated to be a listed hazardous waste (FO32) under RCRA, subject to land ban restrictions. Listed constituents in the LNAPL are likely to be at concentrations in excess of the Universal Treatment Standard (40 CFR 268.48). LNAPL likely would need to be shipped to a hazardous waste treatment facility and incinerated. This is typically an expensive disposal technology, but the high energy content of LNAPL may reduce the cost somewhat. This technology was retained for further consideration.

## 8.2.4 Technologies for Groundwater

Potentially applicable technologies for groundwater remediation are described and evaluated below. These technologies include groundwater monitoring, in situ treatment, and groundwater extraction and treatment.

### 8.2.4.1 Long-Term Monitoring

At the Arlington facility, long-term groundwater monitoring is a component of all groundwater corrective measures alternatives under consideration. Therefore, long-term groundwater sampling and analysis to monitor the plume over time were included in the corrective measure alternatives to be evaluated further.

### 8.2.4.2 Monitored Natural Attenuation

MNA encompasses a variety of physical, chemical, and biological processes that, under favorable conditions, act without human intervention over time or distance to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. MNA is evaluated in the CMS in accordance with the following EPA guidance documents:

- *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (EPA, 1997)
- *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA, 1998)
- *Performance Monitoring of Monitored Natural Attenuation Remedies for VOCs in Groundwater* (EPA 2004)

For this CMS, the term “monitored natural attenuation” will be used consistent with the EPA guidance on MNA (EPA, 2004). These in situ processes include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants. MNA was retained as a corrective measure technology for groundwater.

#### **8.2.4.3 Physical Containment or Barriers**

Physical containment technologies exist to restrict the flow of groundwater so that it cannot migrate offsite or to a point where a potential human or ecological exposure may occur. Physical barrier technologies exist to re-direct the flow of groundwater around contaminated areas, to prevent migration of COCs offsite or to prevent a potential human or ecological exposure. This technology includes the installation of barriers or walls in the subsurface to restrict or re-direct the natural flow of groundwater. Groundwater extraction and treatment and capping are sometimes necessary to minimize the groundwater that builds up behind the barrier. The physical barriers can include slurry walls, grout curtains, or sheet pilings. Such installations typically address shallow groundwater plumes and are installed into an underlying confining or lower permeability layer to prevent underflow around the barrier.

An underlying low-permeability layer is not present at the Arlington facility until approximate depths of 100 feet or more, which is too deep for seating the bottom of a containment wall. Barrier walls constructed without being seated into a lower permeability layer are called “hanging barriers” and typically make groundwater extraction to induce an inward gradient more costly than for barrier walls keyed to an aquitard because higher volumes of water will need to be pumped to establish hydraulic containment. This hanging barrier wall for physical containment is not an ideal remediation technology for groundwater at the site, but because the source material is floating on the top of the water column, this technology was retained for further consideration.

#### **8.2.4.4 Groundwater Extraction and Treatment**

Groundwater extraction and treatment is a proven technique for hydraulic control of affected groundwater. This basic technology involves the installation of recovery wells in a pattern sufficient to capture the groundwater plume at its leading edge, or to fully capture groundwater throughout the plume area, depending on the size of the plume. The recovered groundwater is treated onsite or offsite using treatment technologies appropriate for the specific contaminants in the plume. Although this technology has been used less frequently because of relatively high costs and low mass removal, it is a proven technology for plume containment/control and was retained for further consideration.

Treated groundwater from an extraction and treatment system potentially can be disposed of at a POTW or reinjected into the groundwater plume. Reinjection can be the most cost-effective disposal option for treated groundwater, but typically would be done under a Class V injection permit from Ecology.

#### **8.2.4.5 Funnel and Gate**

A funnel and gate system is a passive remediation method that uses subsurface barrier walls (the funnel) to modify flow patterns so that groundwater flows primarily through high-conductivity gaps

(the gate). The funnel and gate system uses heterogeneous (surface-mediated) reactions on porous media to degrade dissolved contaminants. Typically, it is installed immediately downgradient of contaminant source zones to prevent plume formation. The impermeable funnel serves to modify the natural flow direction toward a permeable gate containing a reactive agent (e.g., iron granules, carbon) that reduces or eliminates contaminant mass.

The funnel and gate technology is relatively new, and reactive media have not been proven for all types of contaminants. Funnel and gate applications typically are applied to chlorinated hydrocarbons, but also have been applied to wood-treating sites. Groundwater bypass around or under the funnel may be a potential problem, particularly in “hanging wall” applications. At the Arlington facility, the funnel would be a hanging wall because the funnel would not be keyed to the underlying aquitard given the excessive depth to the aquitard. Although potentially applicable for the facility, the high hydraulic conductivity of the aquifer and relatively narrow plume width makes the impermeable funnel unnecessary. Based on modeling of a hanging wall (see Appendix G, which was prepared as part of an evaluation of chemical oxidation), bypass of an impermeable wall would be a concern. As a result, the permeable reactive gate likely would be just as effective without the impermeable funnel.

Although these types of passive treatment systems are simple to apply at shallow depths and for low concentration levels of chlorinated organics, their applicability and cost effectiveness are greatly limited at deeper depths and higher concentrations. Replacement of reactive media would be difficult at 30 to 50 feet bgs. Groundwater extraction and treatment (with reinjection) is a functionally equivalent technology has been proven to effectively capture the plume. Replacement of the shallow treatment trench is much easier than replacement of a reactive barrier at depth. Although other technologies may be more appropriate for the facility, the funnel and gate technology was retained for further consideration.

#### **8.2.4.6 Surfactant Flushing**

Surfactant flushing is a remediation technique in which surfactants are used to increase the solubility and mobility of LNAPL or adsorbed soil contamination so that the constituents can biodegrade more easily in the aquifer or be recovered for aboveground treatment by a groundwater extraction and treatment system. The success of this technology requires use of the appropriate surfactant and effectively capturing dissolved-phase constituents via a groundwater extraction system. Surfactant flushing is not commonly used for contaminants with relatively high solubility, such as PCP. A significant concern associated with this technique is that contaminants currently immobilized by capillary forces (e.g., residual LNAPL in the vadose zone) are mobilized by this technology (by increasing solubility). Unless groundwater recovery at a downgradient location is completely effective, the technology can significantly mobilize and further spread contamination. Given the relatively rapid groundwater flow rate in the sand and gravel aquifers underlying the

affected area, and the relatively small dissolved-phase plume, other technologies are more suitable for the Arlington facility. For these reasons, this technology was not retained for further consideration.

#### **8.2.4.7 Air Sparging**

Air sparging (aeration) is a groundwater remediation technology that involves the injection of air or oxygen into a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the saturated aquifer matrix and the soil column, creating an underground biological reactor and stripper that can remove volatile and semivolatile organic contaminants by biodegradation and volatilization. Soil vapor extraction usually is implemented in conjunction with air sparging, when substantial levels of volatile compounds are present to recover and treat the vapor-phase contamination from the vadose zone. In addition, oxygen added to the contaminated groundwater and vadose-zone soils by air sparging can enhance aerobic biodegradation of contaminants below and above the water table. Air sparging has the potential for successful application for the organic constituents in groundwater at the Arlington facility and was retained for further consideration.

An alternate method of aeration is to extract groundwater and recirculate the water through an aeration trench and the vadose zone to form an in situ biological treatment cell. Recirculating the extracted groundwater through the aeration trench would supply dissolved oxygen to the groundwater similar to the effects of air sparging. Aeration trenches can be designed to facilitate oxygenation of the groundwater and can be used to capture the entire groundwater plume and treat the captured groundwater within the aeration trench. Groundwater recirculation to an aeration trench was retained for further consideration as a potential remediation method for groundwater.

#### **8.2.4.8 Enhanced Bioremediation**

Enhanced bioremediation is a process in which indigenous or inoculated microorganisms (e.g., fungi, bacteria, or other microbes) degrade (metabolize) organic contaminants found in soil and/or groundwater, converting them to innocuous end products. Enhanced bioremediation stimulates the activity of naturally occurring microbes by circulating water-based solutions through contaminated soils to enhance in situ biological degradation of organic contaminants. Nutrients, oxygen, or other additives may be used to enhance bioremediation and contaminant desorption from subsurface materials. An in situ application includes the delivery of one or more of the following to the subsurface zone: an electron acceptor (oxygen, nitrate), nutrients (nitrogen, phosphorus), and an energy source (carbon). In a typical in situ bioremediation system, bioremediation amendments are injected directly or groundwater is extracted using one or more wells, mixed with bioremediation amendments, and reinjected upgradient of or within the contaminant source.

In situ groundwater bioremediation can be effective for the full range of petroleum hydrocarbons. Bioremediation techniques have been successfully used to remediate soils, sludges, and groundwater. In general, short-chain, low-molecular-weight, more water-soluble constituents are degraded more rapidly and to lower residual levels than are long-chain, high-molecular-weight, chlorinated, and less soluble compounds. A pilot test currently operating in the groundwater plume at the site has demonstrated that this is a viable technology for the Site. This technology was retained for further consideration.

#### **8.2.4.9 Thermal Treatment**

ERH has been shown to be effective in removal of LNAPL, as noted in Section 8.2.2.1. ERH was retained for further consideration.

#### **8.2.4.10 Chemical Oxidation**

As discussed in Section 8.2.2.4, this technology is potentially applicable at the Arlington facility. Oxidants could be delivered in liquid form for soil treatment or in gas form, similar to air sparging. Instead of injecting air, ozone could be sparged into the injection wells. Ozone is a strong oxidant that would promote the oxidative breakdown of organic contaminants in groundwater (as well as in the saturated and unsaturated soil in the sparge zone) and also deliver oxygen, thereby supporting aerobic biodegradation. This technology was retained for further consideration.

#### **8.2.4.11 Disposal of Extracted Groundwater**

Potential groundwater disposal methods are described and evaluated below. Some disposal methods may require pretreatment, depending on the quality of the extracted groundwater. Inclusion of these technologies in corrective measures alternatives also could occur if short-term groundwater dewatering is required as part of construction.

**Discharge to Sanitary Sewer.** In this disposal option, groundwater is discharged to the local sanitary sewer system. Pretreatment of groundwater may not be required if concentrations of COCs meet discharge criteria. Fees for disposal of groundwater to the sanitary sewer are based on the volume discharged, and periodic chemical and physical monitoring of discharges typically is required. Allowable discharge volumes may be limited, particularly during the wet season. Because this option may allow discharge of groundwater without substantial onsite treatment, it was retained for further consideration.

**Discharge to Surface Water.** Extracted groundwater also may be discharged to surface water, although this discharge option likely would require an NPDES permit. Water discharged to surface water would have to meet strict water quality requirements and likely would require treatment before discharge. This technology was not retained for further consideration because onsite

infiltration is a viable alternative, and the existing infiltration facilities could be used, thereby simplifying implementation.

**Reintroduction to Groundwater.** Extracted groundwater also may be discharged onsite to groundwater via infiltration galleries or injection wells. Treatment requirements for re-infiltration of contaminated groundwater must be evaluated to ensure regulatory requirements would be met. The most likely scenario would be reintroduction of actively treated groundwater through a Class V injection well in accordance with WAC 173-218-040(5)(a)(x). The Class V injection well would require registration in accordance with WAC 173-218-060. This technology was retained for further consideration.

### **8.3 Summary of Retained Technologies**

Based on the evaluation discussed in this section, the following technologies were retained for potential application to site-wide corrective measures alternatives developed in Section 9.

<b>Medium of Concern</b>	<b>Retained Technologies</b>
<b>All Media</b>	<b>Institutional Controls</b>
Soil	Thermal treatment (ERH) Excavation and offsite disposal Soil stabilization Chemical oxidation Enhanced bioremediation
LNAPL	Total fluids (dual-phase) recovery Thermal treatment (ERH) Passive recovery Chemical oxidation Incineration of recovered LNAPL
Groundwater	Long-term monitoring Monitored natural attenuation Physical containment (barrier wall) Groundwater extraction and treatment Funnel and gate Air sparging Enhanced bioremediation Thermal treatment (ERH) Chemical oxidation Discharge to sanitary sewer Reintroduction to groundwater

## **9.0 Corrective Measures Alternatives**

Potentially applicable technology options for the Arlington facility are described and screened in Section 8. In this section, the most promising retained technologies are combined to formulate a range of corrective measures alternatives. Each of these alternatives is evaluated with respect to the corrective measures considerations discussed in Section 6 and evaluation criteria specified in the CMS guidance (EPA, 1994 and 1996) and the AOC (EPA, 2001).

The cleanup technologies suitable for the various areas of the facility that contain COCs in subsurface soil and groundwater could be grouped in various combinations. However, the corrective measures alternatives are selected and limited to compatible cleanup technologies that are combined to protect human health and the environment. The technologies applied to each medium also need to be complementary when implemented in combination.

For this CMS, a broad range of corrective measures alternatives representing a wide spectrum of potentially appropriate remedial technologies was developed. These alternatives include different combinations of MNA, capping, removal, disposal, and treatment. When viewed together, the alternatives present a full range of potential remediation options available for the Arlington facility and recognize trade-offs associated with implementation of different technologies, consistent with the objectives of a CMS. Table 9-1 lists the corrective measures alternatives.

Two technologies described in Section 8 (soil stabilization and funnel and gate) were deemed to be potentially applicable for the facility, but were not included in the six alternatives described in this section, as other technologies were determined to be more appropriate. Soil stabilization, while potentially an effective technology, would be more difficult to implement at the operating facility and have higher costs (given the expansion of soils and requirement for offsite disposal) than other similarly effective technologies (such as thermal treatment, included in Alternative 5). The funnel and gate technology, while also potentially effective, would be more difficult and costly to implement than the enhanced biodegradation recirculation system, which is included in Alternative 4, and which is already in place and meeting project objectives.

Because Parcel B is used only for untreated pole storage and has only one COC detected above proposed cleanup levels, and that COC was present only in shallow soils, corrective action is not appropriate. Therefore, no corrective measures alternatives are presented for Parcel B.

### **9.1 Elements Common to all Alternatives**

The elements common to all of the alternatives are ICs and MNA.

### **9.1.1 Institutional Controls**

ICs would be implemented for the Arlington facility to control future land use under all alternatives, in accordance with federal guidance (EPA, 2000b). Restrictions would be placed on future use of groundwater beneath the facility. Proprietary controls affixed to the deed would include a hazard notice describing the extent and type of contamination at the facility, covenants for appropriate land use restrictions (including groundwater use), and establishment of easements for necessary access, such as access to monitoring wells. The facility also would be registered with local and/or state registries of contaminated sites.

ICs also would be implemented to protect facility workers. A soil management plan would be implemented whereby facility workers would be notified of the existence of soil and groundwater contamination at the facility. This notification would consist primarily of amendments to the facility's health and safety plan and addition of any material safety data sheets to describe the nature and extent of COCs. The soil management plan also would restrict subsurface work within the Main Treatment Area. Subsurface work in this area would have to be approved and authorized by established responsible parties (i.e., facility managers or facility health and safety officers). The soil management plan would outline authorization procedures for the responsible parties, as well as engineering controls and PPE required for performance of subsurface work at the facility.

ICs also would be required for downgradient groundwater that exceeds cleanup levels protective of human health. ICs for downgradient groundwater could be in the form of public awareness and communication.

### **9.1.2 Monitored Natural Attenuation**

MNA of COCs in groundwater is included in all alternatives. For all alternatives, except Alternatives 3 and 4, 20 existing wells would be selected from the existing monitoring well network for groundwater elevation measurements and groundwater sampling. Alternative 3, which includes excavation of the source area, would result in more complete removal of COC-affected soil and fewer monitoring wells would be required (approximately 10). Alternative 4 currently incorporates a monitoring program of 31 existing wells. Wells would include locations in the Northwest Parcel and downgradient wells, which would be used to assess whether MNA is actively degrading COCs in the groundwater plume located in these areas. MNA systems would be designed in accordance with the guidance documents specified in Section 8.2.4.2.

The guidance documents are designed to be used during preparation and review of long-term monitoring plans for sites where MNA has been selected as part of the remedy. Design of the performance monitoring system depends on site conditions and site-specific remedial objectives. This CMS provides information on technical issues to consider during the design process.

MNA refers to natural processes to reduce contaminant concentrations and migration potential from a source in environmental media. MNA processes may reduce the potential risk posed by contaminants at the facility in three ways:

1. The contaminant may be converted to a less toxic form through destructive processes, such as biodegradation or abiotic transformations.
2. Potential exposure levels may be reduced by lowering concentrations of COCs through destructive processes, or by nondestructive processes, such as dilution or dispersion.
3. Contaminant mobility and bioavailability may be reduced by sorption to the soil or rock matrix.

Three types of evidence can be used to assess the effectiveness of MNA of chlorinated organic compounds:

1. Observed reductions in contaminant concentrations along the flow path downgradient from the source of contamination.
2. Documented loss of contaminant mass at the field scale demonstrated by:
  - Evidence from chemical and geochemical analytical data, including:
    - Decreasing parent compound concentrations
    - Increasing daughter compound concentrations
    - Depletion of electron donors and acceptors
    - Increasing metabolic by-product concentrations
  - A conservative tracer to estimate residence time of specific contaminants along the flow path to document mass reduction and to calculate biological decay rates at the field scale.
3. Data from field or microcosm studies that directly demonstrate the occurrence of a particular MNA process at the site and its ability to degrade the COCs.

Long-term monitoring of a contaminant plume can provide empirical evidence of the effectiveness of MNA as a remedy. The long-term monitoring program would include a sampling and analysis strategy that would allow for evaluating the effectiveness of the remedy with respect to the lines of evidence presented above.

Groundwater samples used for MNA would be collected using low-flow sampling methods and analyzed for PCPs and PAHs. Collection of analytical data has demonstrated that site conditions are favorable for MNA. Groundwater analytical samples collected during the pilot study and analyzed for PCPs and PAHs have demonstrated a consistent reduction in plume contaminant

mass and concentration (Baxter, 2010a). A summary of pilot study analytical results and system performance is provided in Section 9.2.4.

To estimate present value costs for the corrective measures alternatives considered in this CMS, a tiered approach to groundwater monitoring was assumed:

1. Monitoring would be conducted semiannually for the first 15 years following implementation of Alternatives 1, 2, 4, and 6. Groundwater elevations would be measured and groundwater samples would be collected during each monitoring event from each of the 31 wells included in the monitoring network. Groundwater samples from all 31 wells would be analyzed for PCP, while seven samples also would be analyzed for PAH compounds and MNA parameters.
2. Monitoring would be conducted annually beginning in Year 16 for Alternatives 1, 2, 4, and 6, and the number of monitoring wells in the network would be reduced to 10. Groundwater elevations would be measured annually and samples would be collected from the 10 wells for analysis of PCP, and four of the samples also would be analyzed for PAH compounds and MNA parameters. For Alternatives 1, 2, 4, and 6, annual groundwater monitoring would occur for approximately 100 years.
3. The monitoring frequency for alternatives where aggressive source control measures are used (e.g., Alternatives 3 and 5) would include semiannual monitoring for the first 5 years, then annual monitoring for an additional 15 years for Alternative 5, and 5 years for Alternative 3, which involves excavation and offsite disposal.

Groundwater samples would be collected using low-flow sampling methods (EPA, 2010a). Quality assurance and quality control sampling would include one duplicate and one equipment rinsate sample collected and analyzed during each sampling event. After selection of a final corrective measures alternative, a detailed performance monitoring plan would be developed.

Results of the groundwater sampling and analysis would be evaluated for changes in the concentrations of COCs, and the results reported to EPA. The decision to reduce the frequency of groundwater sampling to annually and reduce the number of wells monitored would be made based on the concentrations of COCs in tested samples and after approval from EPA.

## **9.2 Parcel A**

This section describes six corrective measures alternatives to address affected soils and groundwater in Parcel A, which consists of the Main Treatment Area and the Treated Pole Storage Area. Each corrective measure alternative addresses affected soils within Parcel A and

groundwater extending downgradient from the Main Treatment Area and Treated Pole Storage Area.

### **9.2.1 Alternative 1: Total Fluids Recovery, Air Sparging, and MNA**

Alternative 1 would provide active recovery of the contaminants in the source area. The technologies employed under this alternative would include total fluids recovery of both LNAPL and groundwater by pumping from extraction wells, air sparging to promote biodegradation, implementation of ICs, and MNA (Figure 9-1).

Total fluids recovery would include groundwater capture at the source area, thereby providing remediation of LNAPL and the most highly contaminated groundwater. Total fluids recovery can be a more aggressive form of LNAPL removal than passive LNAPL extraction; however, all extracted groundwater would need to be treated and disposed of. Treatment of listed waste within a POTW complies with the RCRA/Dangerous Waste regulations, provided that the POTW meets the requirements specified in the permit-by-rule regulations (WAC 173-303-802[4]). In addition, as a result of discussions with EPA and Ecology, the best option for treated water disposal is through reinjection into the aquifer. Disposal by reinjection onsite is a less expensive option and is used for this alternative. In this analysis, it was assumed that the treated groundwater would be discharged to the infiltration gallery installed as part of the current pilot test. Either a RCRA Part B permit, a permit waiver, or a permit-by-rule determination would need to be obtained for the groundwater treatment and injection system, which would be treating and injecting a RCRA-listed waste. An injection permit also would be required from Ecology. Other disposal options, including potential offsite options such as discharge to the POTW or surface water ditch, would be reviewed as part of the detailed design.

For this alternative, three existing wells located directly downgradient of the source area near MW-1 (Figure 9-1) would be used as groundwater recovery wells for total fluids recovery. Each recovery well has been assumed to operate at a flow rate of 15 gallons per minute (gpm) for a combined flow rate of 45 gpm. Based on results from the remedial action pilot study (see Section 9.2.4), which uses a groundwater capture approach with comparable pumping rates, this distribution of recovery wells would recover contaminant mass within the Main Treatment Area and minimize further plume migration.

The extracted fluids would be pumped through an oil-water separator to recover LNAPL. The recovered LNAPL fraction would be characterized for offsite disposal, and the groundwater fraction would be treated onsite by pumping through a granular activated carbon (GAC) treatment system. The GAC treatment system would consist of two GAC vessels piped in series and of sufficient size to handle 45 gpm, plus additional contingency capacity should the remedial strategy change in the future.

Components of an air sparging system include a network of sparging/injection wells and a compressor to supply air. Sparge wells typically are designed to provide overlapping radii of influence to provide continuous coverage along the alignment of the wells. Given the low volatility of site COCs, vapor collection would not be provided because stripping would be minimal. Design of the air sparging system would require a pilot test to determine the radius of influence of the sparge wells and to identify any subsurface formations that would affect air flow. Existing wells could be used to conduct the pilot test.

Based on the findings of the pilot testing, the air sparging system would be designed for this facility. For this CMS, it was assumed that 15 sparge wells, spaced 20 feet apart, would be installed along a line perpendicular to the plume at a location just downgradient of the drip pads near well MW-3, as shown in Figure 9-1. This alignment would create an oxygenated zone of groundwater through which the groundwater would flow, thereby providing conditions to promote aerobic biodegradation of site COCs. The sparge wells may include four new multilevel wells to improve air distribution along the vertical column.

The specific air compressor would be selected after the pilot testing, based on anticipated flow rates and pressure requirements. For this CMS, it was assumed that the compressor would need to provide an air flow of 10 cubic feet per minute (cfm) per well, or a total capacity of 150 cfm. During the design, the pros and cons of using multiple air compressors would be evaluated.

The aboveground air sparging equipment would be housed in a small building. The compressor building would house the necessary equipment and controls to operate the system, including a distribution manifold. The air would be pumped from the compressor building through the manifold, and then to the individual wells via underground distribution piping.

After system installation, an air sparging system monitoring plan would be developed and implemented for up to 100 years, although air sparging systems typically operate for a much shorter duration.

Measurements of dissolved oxygen in the aquifer in the area proposed for biosparging indicate that sufficient oxygen for biodegradation to occur is already present. It is possible that biosparging may not increase the biological activity sufficiently to meet corrective action objectives. If air sparging is found to be inadequate to reduce the size of the groundwater plume, chemical oxidation by ozone sparging could be used as a contingent remedy.

In lieu of injecting atmospheric air through the sparging system, gaseous ozone would be injected with air into the subsurface. Ozone gas would oxidize COCs directly or through the formation of hydroxyl radicals. The oxidation reaction occurs relatively rapidly. Given the instability and reactivity of ozone, the ozone used in the system would be generated onsite and closely spaced

sparging wells would be required. For this reason, the sparge wells that would be installed under Alternative 1 would be spaced so that they would be effective if ozone is used in conjunction with air. Unreacted ozone also would undergo in situ decomposition, which would lead to beneficial oxygen addition to the subsurface. Just as with air sparging, pilot testing would be required before implementation of a full-scale ozonation system.

A long-term groundwater monitoring program would be conducted as part of the MNA component. The long-term monitoring program would involve the use of existing monitoring wells and would be conducted as described in Section 9.1.2.

As part of this alternative, ICs would be implemented at the Arlington facility. ICs also would be required for downgradient groundwater that exceeds cleanup levels protective of human health.

### **9.2.2 Alternative 2: Physical/Hydraulic Containment and MNA**

Alternative 2 includes installation of a hanging, low-permeability barrier wall and total fluids recovery and treatment, as well as ICs and MNA. This alternative is intended to contain the dissolved phase plume by maintaining a groundwater gradient so that groundwater flows toward the containment area. The containment approach would use a low-permeability barrier wall (such as a slurry wall) completely encircling the source area, and total fluids extraction wells placed inside the barrier wall area to reduce the source concentration and induce inward flow to the containment area.

A containment wall ideally would be keyed into bedrock or an aquitard to prevent contaminants from migrating underneath the barrier; however, the great depth of the aquitard at the Arlington facility makes a “keyed” barrier wall installation impractical. Therefore, the wall proposed under Alternative 2 would be installed to an approximate depth of 40 feet to contain the LNAPL and the upper portion of the contaminated groundwater. For this CMS, it is assumed that a 1,500-foot-long slurry wall would be constructed around the Main Treatment Area (Figure 9-2). Use of a soil bentonite slurry wall has been selected for this alternative over other potentially applicable technologies (sheet piling, etc.) because it is readily implemented, has a lower overall cost compared to other technologies, is compatible with site contaminants including LNAPL, and is a proven technology for low-permeability barriers.

Slurry walls are constructed by excavating a trench and then backfilling the trench with an engineered backfill, typically a low-permeability soil or soil and bentonite mixture. A bentonite slurry is used for trench stability during excavation. This operation requires a large area for the use of heavy construction equipment, and sufficient space for staging of excavated soil and mixing the backfill.

“Fluffing” (i.e., increased volume) of the excavated soil as well as addition of admixture (water and bentonite) would generate some excess soil that would require disposal. It is estimated that approximately 25 percent of the excavated soil would have to be disposed of offsite.

To minimize the flow of groundwater under the barrier wall and to extract LNAPL, total fluids extraction wells, as described in Alternative 1, would be used to induce an inward flow gradient. Based on groundwater pumping performed during the remedial action pilot study (see Section 9.2.4), it is anticipated that a relatively low flow rate of 5 gpm for each well would result in a slight inward gradient toward the containment area and result in capture of the plume within the source area. The pumping rate required to maintain an inward gradient would be evaluated as part of a pilot study following barrier wall installation.

The probable location of the containment wall is shown in Figure 9-2. The extracted liquids would undergo the same treatment process and permitting considerations described in Alternative 1 (oil/water separator and GAC units, Section 9.3.1). Similar to Alternative 1, it was assumed that water would be treated onsite under a RCRA Part B permit and disposed of onsite by reinjection. Reinjection would occur in the general location of the existing infiltration trench; however, the trench would require rehabilitation following installation of the barrier wall. Other disposal options would be reviewed during final design.

Alternative 2 would include the same ICs and MNA program as Alternative 1.

### **9.2.3 Alternative 3: Excavation, Offsite Disposal, and MNA**

Alternative 3 is the most intrusive corrective measure to be considered and is based on excavation and offsite disposal of affected subsurface soil and LNAPL in the Main Treatment Area, as well as ICs and MNA. Alternative 3 meets EPA’s preference for an aggressive source removal corrective action, as opposed to a containment approach described in the other alternatives. The excavation would be designed to include the entire source area of soils affected by COCs above the proposed cleanup levels. This would result in an excavated area with a surface extent of approximately 150 by 350 feet, with a maximum depth of approximately 35 feet (accounting for sloped sidewalls). The area of excavation is shown in Figure 9-3. This area currently includes a large portion of the Main Treatment Area and, therefore, would require (1) closure of the wood-treatment facility; (2) demolition of several structures in this area, including the drip pads and aprons; (3) excavation of contaminated soil with offsite disposal; (4) backfilling of the excavation with clean imported fill material; and (5) rebuilding the wood treatment facility. All the affected soil down to the water table would be removed, including most of the LNAPL.

Given that this alternative removes most, if not all, affected source area soils, the COCs in the groundwater would decrease more rapidly through MNA than for the alternatives that do not

include source removal. There is the potential that some affected soil could remain following excavation; these risks would be addressed by ICs.

It is estimated that approximately 52,500 cubic yards (approximately 84,000 tons based on a density of 1.6 ton/cubic yard) of soil would be excavated and disposed of offsite, based on the dimensions of the excavation stated above. Excavated soil would be considered RCRA-listed waste (FO32), which would require disposal at an appropriate hazardous waste landfill after treatment to the Universal Treatment Standard; alternatively, the soils may require incineration to achieve the Universal Treatment Standard.

This alternative would require the facility to be shut down, demolished, and then rebuilt following excavation. Essentially, this alternative would put Baxter (or the current tenant, Stella-Jones) out of business for several months and result in the layoff of employees. The opportunity costs (e.g., loss of sales, continued asset costs during downtime), personnel costs (severance), and the potential for permanent loss of customers would affect the total cost. However, for this CMS, opportunity and personnel costs have not been estimated. This alternative would remove most, if not all, of the source material at the Arlington facility and ultimately could lead to a determination of “Corrective Action complete without controls” by EPA and closure of the AOC.

#### **9.2.4 Alternative 4: Enhanced Biodegradation Recirculation System**

Alternative 4 consists of continued operation of the existing enhanced biodegradation recirculation system, active free product recovery, installation of an enhanced biodegradation recirculation system in the NAPL area, downgradient oxygen infusion, implementation of ICs, and MNA (Figure 9-4).

In January 2008 and after consultation with and approval from the EPA, a pilot study for the enhanced biodegradation recirculation system and passive recovery of LNAPL was implemented to assess the effectiveness of a preliminary version of Alternative 4 (AMEC, 2013) for known contamination associated with the Main Treatment Area at the Arlington facility. The biodegradation system was designed to address affected groundwater immediately downgradient of the source area and to reduce contaminant loading to the groundwater plume, which extends across the Northwest Parcel and to areas immediately downgradient.

A detailed report on implementation and results of the pilot study was presented to EPA in October 2010 (Baxter, 2010a). Additional information has been provided to EPA in a series of quarterly operations and monitoring reports (Baxter, 2010b-c, 2011b-e, 2012b-d, 2013b and c, 2014a-e, and 2015a-c, 2016a-b). Initial costs for installation of the pilot study recirculation system as described have already been incurred, and are not included as part of the cost estimates provided in Section 10 and Appendix C. From late 2007 through the fourth quarter of 2016, Baxter's cost for

installation, performance monitoring, and operations and maintenance of the pilot system was approximately \$1.2 million. Additional monitoring associated with the pilot system is not included in that total.

As presented to EPA on December 14, 2016, Alternative 4 will expand the application of the enhanced bioremediation system with the construction of a recirculation system within the NAPL source area. This bioremediation system would address NAPL in the vadose zone and groundwater in the source area. This system would extract groundwater from the source area and inject it back into the vadose zone within the source area. The proposed recirculation system would utilize a series of drainage columns similar to the gravel columns used during rehabilitation of the Pilot Study recirculation system to distribute extracted water throughout the vadose zone. A pre-design study would be conducted prior to implementation to evaluate appropriate materials and infiltration locations. This alternative would act to augment the existing Pilot Study system by enhancing the degradation of source area material with minimal impact to facility operations.

#### **9.2.4.1 Pilot Study Design**

Implementation of the pilot system for Alternative 4 included installation of a groundwater extraction and re-infiltration field northwest of the source area to treat affected groundwater, and installation of additional groundwater monitoring wells to augment the network of monitoring wells and piezometers used to monitor the remediation progress. The specific installations and requirements are described in the pilot study work plan (Baxter, 2007b).

Seven extraction wells (EW-1 through EW-7) and 19 additional monitoring wells and piezometers were installed (MW-19 through MW-37) and developed (except MW-19 through MW-21) from September to December 2007. The extraction and infiltration piping and vaults were installed during the period of November 12 through December 21, 2007. Installation of the electrical components was completed on January 30, 2008, and the system was commissioned on January 31, 2008.

The seven groundwater extraction wells and the infiltration gallery were constructed in a V-shaped pattern. Groundwater extracted from the extraction wells is infiltrated in the gallery. The infiltration trench is designed to mix the captured groundwater and increase the dissolved oxygen concentration of infiltrating groundwater by using coarse gravel to lengthen the unsaturated flow path of the water. The infiltration gallery also is backfilled with a mixture of crushed limestone and basalt gravel to increase the pH of re-infiltrated water. The pH buffering and aeration are designed to promote biodegradation of PCP in groundwater and natural degradation of PCP located downgradient of the infiltration trench.

In addition to the groundwater recirculation trench, the pilot system also includes a passive recovery system for LNAPL. LNAPL is removed from five source-area recovery wells (MW-12, MW-13, and MW-19 through MW-21) using sorbent socks installed inside the wells.

#### **9.2.4.2 Monitoring Program**

The pilot study included a groundwater monitoring program to monitor progress in achieving remedial action objectives. In total, a network of 40 monitoring wells and piezometers currently is used to monitor pilot system performance. These wells include both previously existing wells plus the new wells installed as part of the pilot study. The pilot study monitoring program currently consists of quarterly groundwater level measurements and water quality sampling. Each quarterly monitoring event includes the following elements:

- Groundwater sampling at selected monitoring wells and analysis of samples for PCP and select PAHs
- Field measurement of groundwater water quality parameters for individual monitoring network wells
- Field measurement of dissolved oxygen concentration and pH in groundwater from extraction wells
- Collection of one field composite sample from the suite of extraction wells and analysis of the composite sample for PCP (and select PCP degradation species beginning in March 2009)
- Inspection of sorbent socks for passive LNAPL recovery and replacement of saturated socks when warranted
- Water level measurements in the monitoring well network

In August 2010, EPA approved Baxter's request to reduce the frequency of selected monitoring tasks from monthly to quarterly (EPA, 2010b). Before August 2010, the following elements of the monitoring program described above had been conducted monthly following installation of the pilot system:

- Extraction well dissolved oxygen and pH measurements
- Extraction well composite sampling, except between April and July 2008 (including analysis of select PCP degradation species beginning in March 2009)
- Water level measurements in the monitoring well network
- Inspection of sorbent socks in the LNAPL recovery wells

In July 2015, EPA approved Baxter's request to reduce the frequency of reporting from quarterly to semiannually. Baxter also requested to reduce the monitoring program from quarterly to

semiannual. Before reducing the monitoring, EPA is requiring a comprehensive monitoring event to be conducted in September 2015 with subsequent quarterly monitoring events in December 2015 and March 2016 (Baxter, 2015). The purpose of the two quarterly events after the comprehensive September 2015 event is to monitor the rehabilitation of the recirculation system that involved the installation of 10 borings within the trench to facilitate infiltration of groundwater. The rehabilitation work was conducted in July 2015 and is further described below.

#### **9.2.4.3 Operations Summary**

Overall system uptime from January 2008 through 2010 was in excess of 90 percent. Beginning in 2011, high water levels were observed in the infiltration gallery, causing automatic system shutdowns. Maintenance activities consisting of well and pump cleaning were conducted in May 2012, which improved infiltration rates in the gallery. In early 2013, high water levels were frequently observed, again causing the system to automatically shut down. A combination of fouling and seasonal high water levels was suspected of causing the high water levels. To improve infiltration rates and assess potential fouling issues, a series of geotechnical borings were installed in the infiltration trench in July 2015. The borings were backfilled with porous rock fill to create vertical infiltration columns extending from the trench deeper into the vadose zone. The vertical infiltration columns are intended to create more surface area for infiltration while generating greater pressure to reduce fouling potential. Following installation, the system was restored normal operation of approximately 40 to 50 gpm cumulative flow. Since restart in August 2015, the rehabilitated system has operated continuously with no high level alarms.

#### **9.2.4.4 Results of Groundwater Monitoring**

Evaluation of PCP plume stability indicates that during the pilot recirculation system's consistent operation, between January 2008 and January 2015, the plume area and the average plume concentration decreased significantly; as shown in the PCP isopleths included in Appendix F. The surficial area of the shallow PCP plume downgradient of the Main Treatment Area and in the Northwest Parcel decreased from approximately 4.4 acres in January 2008 to 3.4 acres in August 2011, with a corresponding decrease in average PCP concentrations from 116 µg/L in January 2008 to 46 µg/L in August 2011 (Figures F-1 and Figure F-4 in Appendix F).

The deeper portion of the PCP plume located downgradient of the MW-15/MW-40 well pair (Figure 9-4) also shows a decrease in areal extent and PCP concentrations during the same time period, although not as pronounced as in the shallow zone (Figures F-9 to F-12 in Appendix F). Overall, the pilot system has proven effective in reducing plume size and PCP concentration in areas downgradient of the Main Treatment Area when in full operation

Apparent fouling or silting in the infiltration trench between 2012 and 2013 reduced capacity and operating flow rates of the recirculation system. Consequently, a temporary rebound in concentrations occurred, to an average PCP concentration of 131 µg/L within the shallow zone has

been observed (Figures F-7 and F-8 in Appendix F). A return to regular operation in August 2015 has been followed by constant system operation to date. Subsequent 2016 sampling events have demonstrated re-established hydraulic capture and reduction of the downgradient PCP plume (Figure-9 in Appendix F).

The groundwater recirculation system for recovery of the groundwater plume demonstrates the ability to consistently achieve groundwater capture, and recirculation of the contaminated groundwater is resulting in degradation of the PCP downgradient of the infiltration trench. Based on historical measured concentrations of PCP in the recovered groundwater being infiltrated (recirculated), the primary benefit of the infiltration trench is to reduce the overall PCP concentrations in groundwater in the center of the plume, resulting in PCP concentrations much more amenable to biodegradation of the PCP. The dilution of PCP improves conditions supporting biodegradation of the PCP plume, especially in areas immediately downgradient of the remedial action pilot study.

#### **9.2.4.5 Enhanced Biodegradation Recirculation System in Source Area**

Work to date for the bioremediation system operating in the plume demonstrates that the technology is effective at degrading PCP in groundwater. A source area bioremediation system would address NAPL in the vadose zone and underlying impacted groundwater. This system would extract groundwater from the source area and inject it back into the vadose zone within the source area. Nutrients would be metered into the recirculating groundwater to promote optimal growth of COC degrading bacteria. The recirculating groundwater would be aerated in the well head vault to add oxygen to the groundwater. Figure 9-4 shows an array of 7 extraction wells and 15 shallow injection points that would provide treatment in the source area. The system would be constructed to be flush with the ground surface to allow continued operations at the site. Laboratory testing would be conducted to determine the amount and type of nutrients to add for optimal growth of PCP degrading microbes.

#### **9.2.4.6 In Situ Oxygen Infusion**

Natural aerobic biodegradation processes have been the observed mechanism in reducing the trailing edge of the dissolved PCP plume, downgradient of the main treatment area. To enhance ongoing aerobic processes within the deeper downgradient plume, oxygen infusion units were installed in monitoring wells MW-39, MW-40, and MW-41 on August 1, 2015. The oxygen infusion units act as part of an in situ submerged oxygen curtain (iSOC) whereby compressed oxygen gas is infused into the respective well to supersaturate the oxygen content of the water column. Subsequent mixing with the connected aquifer is intended to further stimulate aerobic biological processes and hasten degradation of COCs. The iSOC infuser deployment is intended to be a temporary treatment for downgradient, high concentration zones and will be pragmatically deployed depending on site conditions. Following implementation of the source area recirculation

system, iSOC units may be recalled or deployed as necessary depending upon the deeper groundwater plume's mobility and extent.

#### **9.2.4.7 LNAPL Recovery**

Passive LNAPL recovery has been conducted as part of the pilot study. The amount of LNAPL recovered using sorbent socks in MW-12 from January 2008 through the fourth quarter of 2016 was 68.4 pounds. During the same period, LNAPL recovery from sorbent socks in MW-13, MW-19, MW-20, and MW-21 was limited (6.04 pounds combined). At the time the LNAPL recovery wells were installed, free product was observed in MW-12, MW-13, and MW-19. Currently, LNAPL is being removed on the sorbent socks at well MW-12 without any recovery from other wells. To improve the rate of LNAPL recovery, a skimmer pump will be installed into MW-12. The well would be pumped at a low rate, to prevent significant groundwater drawdown and enhance LNAPL flow towards the well, as part of the in situ bioremediation treatment discussed above.

### **9.2.5 Alternative 5: ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation**

Alternative 5 includes ERH, total fluids recovery, and enhanced biodegradation recirculation, as well as ICs and MNA (Figure 9-5). This alternative is intended to address the source area by treating the unsaturated and saturated zones simultaneously. Ideally, nearly the entire subsurface source area would be heated to the boiling point of the contaminant/water mixture. As the treatment area is heated, the contaminants may be removed from the subsurface as separate phase liquids, dissolved phase liquids, or as vapors by the total fluids and vapor recovery system. The only part of the known source area not heated would be areas with woodwaste backfill. This area would not be heated, to minimize drying of the woodwaste and the associated hazards (fire and subsidence).

As shown in Figure 9-5, two distinct areas have been targeted for treatment, based on the observed presence of residual LNAPL in boreholes. In the southern area, heating would extend from 5 to 35 feet bgs. Heating of the northern area would be complicated by the presence of wood chips found in the shallow vadose zone from near surface to approximately 10 feet bgs. To avoid the wood chips, heating in the northern area would extend from 15 to 35 feet bgs. Residual LNAPL is likely present within the wood chips and would not be treated.

To ensure robust heating, electrode spacing in each area would be set to 17 feet on center, producing a conservatively high power density of 103 electrodes throughout the treatment area (Figure 9-5). To measure and record subsurface heating, six temperature monitoring points would be placed in each treatment area and thermocouples would collect temperature data at 5-foot increments from the top of the heating intervals to a depth of 40 feet bgs. Data from the thermocouples would be collected automatically by the ERH power delivery system and used to

prepare a subsurface thermal profile of the volume being heated. Electrodes would be placed to avoid site structures, buildings, roads, and rail road tracks.

Total fluids recovery would include wells capable of recovering LNAPL, groundwater, steam, and contaminant vapors from the subsurface. Liquids extracted from the subsurface would be routed from the wells by conveyance piping and passed through a liquid waste management system consisting of an oil/water separator, condenser, and liquid phase GAC vessels. Once through the GAC system, the water would be recycled to the electrodes as wetting water, and the recovered LNAPL would be characterized for offsite disposal. Recovered vapors would pass through the condenser to be cooled and separated from steam and then treated using vapor phase GAC vessels.

Total fluids recovery can be a more aggressive form of LNAPL removal than passive LNAPL extraction; however, all extracted groundwater would need to be treated and disposed of. Treatment of listed waste within a POTW complies with the RCRA/Dangerous Waste regulations provided that the POTW meets the requirements specified in the permit-by-rule regulations (WAC 173-303-802[4]). In addition, as a result of discussions with EPA and Ecology, the best option for treated water disposal is through reinjection into the aquifer. Disposal by reinjection onsite is a less expensive option and would be used for this alternative. In this analysis, it was assumed that the treated groundwater would be discharged back into the electrodes as wetting water. Either a RCRA Part B permit, a permit waiver, or a permit-by-rule determination would need to be obtained for the groundwater treatment and injection system, which would be treating and injecting RCRA-listed waste. An injection permit also would be required from Ecology. Other disposal options, including potential offsite options, such as discharge to the POTW or surface water ditch, would be reviewed as part of a detailed design.

Components of the ERH system include a network of 100+ electrodes/recovery wells, traffic-rated well vaults, conveyance piping, electrical infrastructure, temperature monitoring points, and a liquid and vapor waste management system. Electrodes are typically spaced between 15 and 20 feet apart to provide uniform heating in the subsurface. It is expected that 130 days of heating would achieve a 90 percent reduction of PCP concentrations in soil; however, the cost estimates include an additional 3 months of heating to ensure complete remediation. It is anticipated that 90 percent destruction of the COC mass in the source area would result in sufficient reduction of dissolved-phase constituents in groundwater, such that natural attenuation process would rapidly degrade residual COCs in downgradient locations. Groundwater monitoring would be required to determine the effectiveness of the alternative following treatment.

During the initial 4 to 5 years after implementation of ERH, the existing enhanced biodegradation recirculation would be operated as described in Alternative 4 to control any COC-affected

groundwater flowing from the source area. Commonly, ERH results in a temporary spike in COCs dissolved in groundwater during the treatment process, as the heating mobilizes COCs.

### **9.2.6 Alternative 6: Chemical Oxidation and Enhanced Biodegradation Recirculation**

Alternative 6 combines chemical oxidation, enhanced biodegradation recirculation, ICs, and MNA to remediate COCs (Figure 9-6). Pilot testing would be performed at four injection locations and include three injection events separated by 2 weeks, using an oxidant such as Regenox. Depending on pilot testing results, the technology may be screened out, the oxidant could be changed, and/or the dose may be reduced. Current design includes three injection events with injection points set 10 feet off center; however, this technology can be implemented in phases as appropriate. The initial design includes 60 injection points in the north treatment area, 80 injection points in the south treatment area, and four injection points in the pilot test area for each event. The treatment areas are shown in Figure 9-6.

The results of a treatability study using site soil within the proposed oxidant injection zones found the requisite oxidant demand to be 23 grams per kilogram (g/kg) to achieve a mass reduction of approximately 50 percent (Appendix H). Scaled to the size of the proposed treatment area, an approximate oxidant injection of 800,000 pounds would be required. However, pilot testing would be needed to account for in situ conditions that may require much greater quantities of oxidant to achieve bench scale results.

Injection areas from the three events would overlap, with injection points offset to improve chances of oxidant contact with COCs. The highest overlap would occur in the areas with greatest LNAPL thickness; areas with little to no LNAPL may be treated only once. The estimated time for all three injections could range from 3 to 7 months, depending on drill rig availability and pilot test results. Alternatively, the injections could be phased over several years, with monitoring between each phase to determine the effectiveness of each treatment. The phased approach could be effective to either limit the total number of injections (and overall cost), or increase the total number of injections in specific areas to ensure treatment. For this CMS, costs for three treatments are included in year 1 with a total oxidant usage of 800,000 pounds (Appendix C).

As described in Section 9.1.2, a long-term groundwater monitoring program would be conducted, including semiannual sampling with laboratory analysis for site COCs. The monitoring program would assess whether natural attenuation is actively degrading COCs and assess progress toward attainment of remediation objectives. A subset of the existing monitoring wells would be used for monitoring.

Alternative 6 has minimal impact on site operations. Injection by push probe would occupy a small footprint onsite. Injections would occur after business hours and areas treated would be immediately available for site use the following day. Alternative 6 meets EPA's preference for an aggressive source removal corrective action, as opposed to a containment approach described in the other alternatives. However, injections would have to occur at depths greater than 10 feet to prevent surfacing of the oxidant. As a result, shallow soil likely would not be treated. In addition, some areas of the site would be untreatable because of woodwaste backfill. Push probe cores would be considered RCRA-listed waste (FO32), which would require disposal at an appropriate hazardous waste landfill after treatment to the Universal Treatment Standard; alternatively, the soils may require incineration to achieve the Universal Treatment Standard.

Because this alternative does not remove all affected source area soils (approximate 50 percent reduction, depending on results of pilot testing), the COCs in the groundwater would decrease more rapidly through MNA than under the alternatives that do not include source removal. It is likely that some affected soil could remain following treatment including in the woodwaste; these risks would be addressed by ICs.

### **9.3 Parcel B: Untreated Pole Storage Area**

Corrective action is not warranted in Parcel B because multiple factors indicate that exposures are already protective of human health in an industrial use scenario. There is only one soil sample collected from Parcel B that exceeds a proposed cleanup level, and it is for one COC. Soil sample SB-57, on the south end of the parcel, contained RRO at a concentration of 5,300 mg/kg in subsurface soil (4 to 6 feet bgs), which exceeds the proposed cleanup level of 2,000 mg/kg by less than 1 order of magnitude. This parcel has had no known industrial activity from the wood-treating operations, and is used only for untreated pole storage. The soil sample collected below SB-57 (12 to 14 feet bgs) at the same location did not exceed proposed cleanup levels, and neither did any other soil samples from the parcel, indicating that the extent of RRO in this area is minimal. Also, an industrial worker would be exposed to soil throughout the parcel, not just at a single location at 4 feet bgs. To estimate a conservative exposure point concentration for an industrial worker in Parcel B, a 95 percent upper confidence limit on the mean (95 percent UCL) was calculated, using EPA's ProUCL tool, v.5.0, for all Parcel B soil data from zero to 15 feet bgs (29 samples). This is the reasonable depth to which an industrial worker might be exposed to soil. The 95 percent UCL for RRO in Parcel B is 704 mg/kg, which is below the proposed cleanup level of 2,000 mg/kg, indicating existing exposures are protective of human health. In addition, groundwater in Parcel B is not affected by COCs at concentrations above proposed cleanup levels. For these reasons, the only corrective measure needed for this parcel is ICs, including a deed restriction limiting Parcel B to industrial use, which is consistent with the current use and long-term zoning. For this parcel, development and comparison of corrective measures alternatives are unnecessary.



## 10.0 Detailed Evaluation of Alternatives

Section 9 described a range of corrective measure alternatives potentially applicable to the Arlington facility. This section contains a detailed analysis of each of these alternatives. EPA guidance (EPA, 1994 and 1996) establishes a two-phase evaluation process for corrective measures studies. The first phase is a screening to determine if alternatives meet specified threshold criteria that apply to all alternatives considered. The threshold criteria specified in the 1994 guidance have been incorporated into CMOs for this CMS. The corrective measures alternatives considered in this CMS have been developed to attain remedial objectives; therefore, all alternatives evaluated in the CMS attain the threshold criteria.

The second phase of evaluation is assessment of each alternative versus a set of balancing criteria. The balancing criteria are generally defined in the CMS guidance (EPA, 1994 and 1996). EPA's AOC (EPA, 2001) has established a slightly different and more detailed set of balancing criteria that must be followed for this CMS. Meeting these AOC criteria generally would address the criteria identified in EPA's CMS guidance. Therefore, the criteria specified in the AOC are considered in this CMS report, and no evaluation against the specific balancing criteria cited in the 1996 CMS guidance was conducted.

The balancing criteria identified in the AOC have been separated into technical criteria, human health criteria, environmental criteria, institutional criteria, and cost. The technical criteria have been further subdivided into performance, reliability, implementability, and safety. All of the balancing criteria used in this CMS are defined in Table 10-1. These criteria are generally consistent with the evaluation criteria specified in the MTCA regulations for feasibility studies and with the balancing criteria cited in EPA's 1996 CMS guidance.

Each of the corrective measures alternatives described in Section 9 is evaluated relative to the balancing criteria in Sections 10.1 through 10.6. Alternatives are rated qualitatively for effectiveness relative to each of the balancing criteria on a scale of 1 to 4, with 1 representing low effectiveness and 4 representing high effectiveness. Table 10-2 summarizes the alternatives evaluation. Cost estimates for each of the alternatives are summarized in Table 10-3, and detailed cost estimates are included in Appendix C.

All alternative costs are based on contractor or engineer estimates, and include costs for planning, permitting, engineering, installation, and construction management. In addition, annual (i.e., long-term costs) include estimates for ongoing operations and maintenance, periodic equipment replacement, labor for groundwater monitoring, laboratory analysis, and semiannual or annual reporting. No costs are included for interruption of operations, such as loss of rent for business interruption. The tenant may claim frustration of the lease and terminate the lease where the

interruption occurs for an extended period. These costs can be determined only after all engineering requirements are established. Finally, all future costs are discounted to present-day costs using a discount factor of 1.1 percent.

A comparative analysis of the alternatives is presented in Section 11, based on ranking of the alternatives in their relative performance with regard to both the threshold criteria and the balancing criteria.

## **10.1 Alternative 1: Total Fluids Recovery, Air Sparging, and MNA**

Alternative 1 includes LNAPL and dissolved-phase contaminant extraction within the source area using total fluids recovery, with groundwater remediation of the plume immediately downgradient of the source area by air sparging. Total fluids recovery would aggressively recover LNAPL and would provide hydraulic containment of the source area. This potentially feasible combination of remediation technologies provides an aggressive approach to both LNAPL recovery and groundwater remediation. ICs to limit potential direct exposure to affected groundwater and/or soil would be implemented under this alternative along with long-term groundwater monitoring.

### **10.1.1 Technical Criteria**

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as shown in Table 10-1. Alternative 1 is evaluated against these technical criteria in the following subsections. The overall rating is shown in Table 10-2.

#### **10.1.1.1 Performance**

Alternative 1 would enhance the ongoing natural biodegradation processes in the plume downgradient of the source area with air sparging, which is expected to accelerate biodegradation reactions by establishing and maintaining aerobic conditions. Aggressive source control would be included to remove LNAPL and highly contaminated groundwater, thereby reducing the toxicity, mobility, and volume of affected media and accelerating cleanup. Recovered groundwater would be treated to permanently destroy dissolved COCs.

Total fluids recovery, meaning pumping of both groundwater and associated LNAPL, has proven effective in recovering LNAPL and contaminated groundwater. Given that groundwater is recovered in the immediate vicinity of the LNAPL, it is likely that more highly contaminated groundwater would be recovered compared to pumping downgradient of the source area, providing more contaminant mass recovery. Recovered COCs would be permanently destroyed as a result of groundwater treatment and LNAPL disposal.

Aerobic biodegradation of degradable constituents by air sparging downgradient of the source area would effectively and permanently destroy biodegradable constituents and reduce both the toxicity and volume of media affected by biodegradable COCs at the facility. As noted previously, natural conditions have served to immobilize many COCs because of soil sorption, thereby limiting the extent of migration to areas immediately downgradient of the facility boundary. The engineering systems included to facilitate biodegradation and to recover LNAPL are proven technologies, but require periodic operator attention and maintenance to operate effectively. The useful life for the air sparging system is typical for mechanical systems; major mechanical components likely would require replacement after 10 years of operation.

Mobility of COCs would be limited because of the hydraulic containment created by the operation of the total fluids recovery wells. By inhibiting high-concentration COCs to migrate downgradient and using air sparging to accelerate biodegradation rates, this alternative is expected to result in the cut-off of the plume downgradient of the total fluids recovery wells, or hydraulic containment system, which ultimately would result in the contraction of the groundwater plume's leading edge through attenuation by dilution and degradation. If fluid recovery pumping or air sparging were to fail, system warnings would indicate the malfunction; given the high hydraulic conductivity of the aquifer, system effectiveness would decrease shortly after a shutdown, and source area groundwater containing elevated COC concentrations would migrate downgradient of the remediation system.

Alternative 1 would provide a comparatively rapid reduction in the toxicity and volume of COCs, particularly in the source area. Alternative 1 also would reduce the contaminant loading to the downgradient portion of the plume, which would improve the rate of COC degradation caused by the air sparging system. Potential risks to downgradient receptors would be minimal, based on the limited future mobility of COCs caused by the combination of remediation technologies applied in this alternative.

Based on the above considerations, this alternative is rated moderately high for effectiveness and for reduction in the toxicity, mobility, and/or volume of affected media. Alternative 1 is rated low for useful life because of its reliance upon multiple mechanical systems that require frequent operation and maintenance.

#### **10.1.1.2 Reliability**

Alternative 1 incorporates two mechanical systems (the total fluids system and the air sparging system) for corrective action with high operational and maintenance requirements. Both the total fluids recovery and the air sparging systems require periodic operator attention for proper operation. Given that both systems include rotating equipment, regular maintenance is necessary. The groundwater treatment process required for operation of the total fluids system also requires

operator attention and regular monitoring so that permit requirements are attained and that the GAC units are replaced as needed. Based on these considerations, this alternative is rated low for long-term operation and maintenance.

Both air sparging and total fluids recovery have been proven appropriate for remediation of wood-treating sites. However, both components rely on mechanical equipment to provide remediation; mechanical equipment can fail, and failure of the equipment would render this alternative ineffective for short time periods. Given the reliance of this alternative on two separate mechanical systems that periodically fail, this alternative is rated low for demonstrated and expected reliability.

#### **10.1.1.3 Implementability**

This alternative would require fairly extensive construction to install the LNAPL collection system, groundwater treatment system, treated water discharge piping, air sparging wells and equipment, and power systems. Wells currently used as passive LNAPL recovery wells would be converted to total fluids recovery wells. Construction would require coordination with ongoing facility operations. For these reasons, construction would require careful planning and onsite management so that it is done safely and properly. The long-term groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring for the air sparging system. Fairly extensive construction, including tanks, vessels, piping, and controls would be required for a groundwater treatment system of the required size.

Implementing this alternative would require disposal of treated groundwater in accordance with applicable regulations. For this CMS, it is assumed that treated groundwater would be discharged to the subsurface through the existing or a newly constructed infiltration gallery. Subsurface infiltration of the water would require appropriate permitting and onsite treatment would require either a RCRA Part B permit, a permit waiver, or a permit-by-rule determination.

The ICs included in this alternative could be readily applied to the facility and affected downgradient groundwater. It is expected that beneficial results would be attained in a comparatively short time frame for Alternative 1. For these reasons, Alternative 1 is rated moderately low for both constructability and implementation time and moderately high for beneficial results time frame.

#### **10.1.1.4 Safety**

Alternative 1 could be implemented with moderate concerns for safety. Recovery of LNAPL could create some safety concerns for direct contact with the NAPL and for fire. Safety concerns would result from operation of a groundwater treatment system with contaminated groundwater mixed with LNAPL in above-grade piping and vessels. Air sparging would not create significant safety

issues because most COCs have fairly low vapor pressure. This alternative is rated moderately low for safety.

### **10.1.2 Human Health Criteria**

Alternative 1 is rated moderately high for minimizing short-term exposure to COCs at the facility, because minimal invasive construction work is needed for implementation. This alternative is rated moderately high for minimizing long-term exposure because it contributes to active degradation of many COCs and to aggressive recovery of LNAPL. There is some potential for human exposure, resulting from recovery of LNAPL and the associated operation and maintenance activities for the total fluids recovery and air sparging systems.

### **10.1.3 Environmental Criteria**

Alternative 1 would rapidly provide hydraulic containment near the source area, aggressively recovers LNAPL, and provides enhanced bioremediation for the downgradient plume. Minimal short-term effects (adverse or beneficial) would result from implementation of this alternative because only minimally invasive construction is necessary within affected media. Long-term beneficial effects would occur comparatively rapidly, although these beneficial effects would reach a steady-state condition rapidly because of the limitations of pump and treat systems in removing COC mass. This alternative would not produce any adverse long-term effects, and is ranked moderately high for environmental criteria.

### **10.1.4 Institutional Criteria**

Alternative 1 is rated moderately low for institutional criteria because it may be difficult to obtain the necessary permissions for discharge of treated groundwater and to address RCRA permitting requirements. Discussions with the City of Arlington indicated that the local POTW may not have the capacity to accept the anticipated flow rate of treated groundwater on a long-term basis. There are also several permitting and administrative impediments related to the surface discharge. For the purposes of this CMS, it has been assumed that treated groundwater would be discharged to the existing infiltration gallery installed as part of the pilot study for Alternative 4 (Section 9.2.4). Additionally, construction of the facilities needed for the total fluids groundwater/LNAPL recovery and treatment system, in addition to the air sparging system, could interfere with ongoing facility operations.

### **10.1.5 Cost**

The estimated total net present value for this alternative (based on the assumptions used for estimation) is \$5,217,400. However, the cost potentially could be much higher if treated groundwater could not be disposed of via onsite infiltration or at the local POTW. If it is necessary

to transport the treated water for disposal at another POTW, it could increase annual costs by \$2 million to \$3 million, which would substantially increase the net present value. Business interruption and loss of lease income also could substantially increase the cost over the above stated estimate. First-year costs associated with this alternative would include costs to install 15 air sparging wells, a groundwater treatment system, and associated piping and equipment plus program costs and costs to implement ICs. Annual costs would include operation and maintenance costs (for air sparging, total fluids recovery, and groundwater treatment), maintenance of ICs, and groundwater monitoring for 100 years. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed estimate worksheets are included in Appendix C. Given its high cost, this alternative is rated moderately low for the cost criterion.

## **10.2 Alternative 2: Physical/Hydraulic Containment and MNA**

Alternative 2 would provide physical/hydraulic containment for contaminated groundwater by (1) construction of a barrier wall around the most highly affected area, and (2) implementing a total fluids recovery program inside the barrier wall to recover LNAPL and establish hydraulic control. A groundwater recovery/treatment system would be employed to recover LNAPL and the most highly affected groundwater. LNAPL would be separated and the affected groundwater would be treated to attain discharge criteria. MNA would address affected groundwater outside the containment area. A hanging, low-permeability barrier wall would be installed around the source area using conventional slurry wall methods. This alternative would combine physical containment with an LNAPL and groundwater recovery program.

### **10.2.1 Technical Criteria**

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined in Table 10-1. Alternative 2 is evaluated against these technical criteria in the following subsections. The overall rating is shown in Table 10-2.

#### **10.2.1.1 Performance**

Alternative 2 would rely on a hanging barrier wall and active groundwater pumping using the total fluids recovery concept to provide hydraulic containment and to recover LNAPL from the subsurface. MNA would limit the toxicity and mobility of site COCs within groundwater downgradient of the source area. The physical/hydraulic containment system could be effective, provided that active pumping is maintained. If pumping were to fail or stop, system warnings would indicate the malfunction; however, given the absence of an aquitard at a reasonable depth and the high hydraulic conductivity of the aquifer, the system would become ineffective shortly after a shutdown and affected groundwater inside the barrier wall likely would migrate beyond the wall. However, the hanging barrier wall would limit contaminant flow from the source area during shutdown of the total fluids system; this alternative would provide improved performance over

Alternative 1. MNA would remain active for degradation of many constituents in groundwater, but the rate of attenuation would be generally slow.

Biodegradation of COCs in the downgradient plume would permanently destroy the COCs, gradually reducing both the toxicity and volume of affected groundwater. COCs present in groundwater recovered at the facility would be removed from the groundwater and destroyed permanently; this would contribute to reduced toxicity and mobility within the source area. There would be a reduction in the volume of LNAPL resulting from recovery using the total fluids approach, although complete LNAPL removal would be unlikely. The mobility of COCs in the source area would be reduced because of the physical and hydraulic containment system. Even if the groundwater recovery component failed, the hanging barrier wall would reduce mobility of the LNAPL somewhat. Mobility of the groundwater plume also would be moderately reduced by lengthening the flow path for affected groundwater and by limiting the flux of groundwater from the source area.

The engineering controls included in this alternative to recover LNAPL and provide containment are generally simple and proven reliable, provided that active pumping is maintained. The useful life for the barrier wall would be long because it would be constructed of earthen materials and likely would fail only if a major earthquake affected the facility. The useful life for the groundwater recovery and treatment components is not expected to be long; active pumping and treatment would require operator attention, periodic maintenance, and periodic replacement of wells and equipment. Given that LNAPL recovery included in Alternative 2 would address only mobile LNAPL that readily flows to the collection facilities, LNAPL recovery would not be expected to have a long useful life. The estimated pumping rate, which is based on pumping performed during the pilot study described in Section 9.2.4, would need to be confirmed during detailed design studies. Because of the hydrologic setting (i.e., high transmissivity and hanging wall not keyed into an aquitard), pumping inside the barrier would create an upward gradient with the pumping well acting as a partially penetrating well. Consequently, a hanging barrier wall may not provide a substantial reduction in the pumping rate required to achieve hydraulic control compared to hydraulic containment using extraction wells alone.

Based on these considerations, this alternative is rated moderately high for effectiveness and for reduction in toxicity, mobility, and volume, and moderately low for useful life.

#### **10.2.1.2 Reliability**

Alternative 2 would incorporate a total fluids approach for groundwater and LNAPL recovery and treatment; this system relies on mechanical systems and equipment. The system would require substantial long-term operation and maintenance for most reliable performance; however, the barrier wall alone would provide a nominal level of containment in the absence of the total fluids

recovery component. Given that both the groundwater recovery and treatment components include rotating and electronic equipment, regular maintenance would be necessary. The groundwater treatment system also would require regular monitoring and maintenance, especially for the GAC units providing primary removal of groundwater COCs. Based on these considerations, this alternative is rated moderately low for long-term operation and maintenance.

All components of this alternative have been proven appropriate and reliable for remediation of wood-treating sites. Given that the hanging barrier wall alone would not provide full physical containment, the alternative may provide only partial containment of the source area if the groundwater recovery and treatment system fails; such a failure likely would result in the loss of affected groundwater from the source area, potentially affecting downgradient groundwater. Given these considerations, Alternative 2 is rated moderately low for demonstrated and expected reliability.

#### **10.2.1.3 Implementability**

This alternative would require extensive and highly invasive construction to install the barrier wall using either conventional slurry wall or other applicable barrier wall installation techniques (e.g., vibrated beam barrier wall). This alternative would be difficult to implement. Excavation and containment wall construction would be complicated by the presence of existing structures, including buildings, drip pads, rail lines, underground lines or utilities, and the Treated Pole Storage Area. The Arlington facility is also an active industrial facility, and ongoing facility operations would be disrupted by required construction work. Additionally, the groundwater collection piping, the groundwater treatment system, and the treated water discharge piping must be installed. Significant permitting issues could be encountered if the Arlington POTW cannot commit to accepting treated groundwater for the long-term, and it is not feasible to transport the water to another POTW by truck or pipeline. It is expected that a RCRA Part B permit, a permit waiver, or a permit-by-rule determination would be needed to treat the groundwater; the RCRA permitting or waiver process is expected to be lengthy and complex. For this CMS, it is assumed that treated groundwater would be discharged to the subsurface through an infiltration gallery. Specifically, the existing infiltration trench would be rehabilitated following barrier wall installation. Constructability for this alternative would be difficult. Given the difficult constructability and permitting requirements, the implementation time would be fairly long, likely in the range of 3 to 4 years.

The ICs included in this alternative would apply to the Arlington facility and affected downgradient groundwater and could be readily implemented. Significant beneficial results would accrue immediately upon completing construction of the barrier wall and groundwater recovery and treatment system. Beneficial results would continue as long as the groundwater recovery and treatment system remained in operation.

Based on the considerations presented above, Alternative 2 is rated low for constructability, moderately low for implementation time, and moderately high for beneficial results time frame.

#### **10.2.1.4 Safety**

Significant safety concerns would result from implementation of Alternative 2. These concerns would affect remediation workers and onsite production workers. Safety concerns include potential exposure to affected soil during barrier wall construction, potential exposure to LNAPL or affected groundwater during excavation, and the normal construction safety concerns related to construction using heavy equipment. Additional safety concerns unique to slurry wall installation include potential trench failure resulting from the depth of the slurry trench and the potential effects of failure on adjacent structures, underground utilities, and rail lines. Safety issues related to trench failure would be less relevant in the case of vibrating beam technology. Minor safety concerns also would result from long-term operation and maintenance of the groundwater recovery and treatment system; operation and maintenance could lead to exposure of workers to contaminated groundwater. This alternative is rated moderately low for safety.

#### **10.2.2 Human Health Criteria**

Alternative 2 is rated moderately low for minimizing short-term exposure to COCs at the facility because of the extensive, invasive construction typically associated with construction of barrier walls and recovery of contaminated groundwater and LNAPL. The alternative is rated moderately high for minimizing the potential for long-term exposure caused by recovery of highly contaminated groundwater for hydraulic control and natural degradation/immobilization of COCs in the downgradient plume. There is some potential for human exposure resulting from recovery of LNAPL and to operation and maintenance activities needed for groundwater treatment.

#### **10.2.3 Environmental Criteria**

Alternative 2 is rated moderately high for these criteria because the containment and recovery of affected groundwater combined with recovery of mobile LNAPL. Substantial short-term adverse effects could result from implementation of this alternative, but the potential for these effects can be minimized. Implementation of this alternative would achieve many remedial objectives within a short time, providing short-term beneficial effects. Long-term beneficial effects would accrue because of continued groundwater pumping; long-term adverse effects could result from failure of the groundwater recovery and treatment system. In the long term, not all LNAPL in the source area would be removed by the pump-and-treat system, and, as a result, the beneficial effects are roughly equivalent to the other containment strategies.

#### **10.2.4 Institutional Criteria**

Alternative 2 is rated low for institutional criteria because it would require extensive, invasive construction work for implementation and would adversely affect facility activities and operations during implementation. Excavation and containment wall construction would be complicated by the presence of existing structures, including buildings, drip pads, rail lines, and treated pole storage area. Mitigation measures would be required to minimize the potential for short-term exposures during implementation. Significant permitting, including either a RCRA Part B permit, a permit waiver, or a permit-by-rule determination, would be required for implementation of this alternative because the recovered groundwater would be a RCRA-listed waste. The same institutional issues identified for Alternative 1 would apply to this alternative, even though the volume of recovered groundwater would be lower.

#### **10.2.5 Cost**

Assuming that treated groundwater could be disposed of via an onsite infiltration gallery, the estimated total net present value for this alternative is approximately \$5,538,200. The cost would be significantly higher if treated groundwater could not be disposed of via infiltration or if pumping requirements to obtain plume capture are greater than anticipated. Business interruption and loss of lease income also could substantially increase the cost above the stated estimate. First-year costs associated with this alternative would include costs to install a 1,500-foot-long containment wall, installation trench rehabilitation, three groundwater recovery wells, a groundwater treatment system, associated piping, and equipment; disposal costs for soil excavated for construction; plus implementation costs for the remediation program and ICs. Annual costs would include maintenance of ICs, operation of the groundwater treatment system, maintenance of the containment wall and treatment system, and groundwater monitoring for 100 years. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed cost estimate worksheets are included in Appendix C. This alternative is rated moderately low for cost, based on its moderately high net present value cost.

### **10.3 Alternative 3: Excavation, Offsite Disposal, and MNA**

Alternative 3 is based on the excavation and offsite treatment/disposal of the affected subsurface soil and LNAPL in the Main Treatment Area and MNA for the downgradient groundwater plume. To excavate and recover affected soil and LNAPL, it would be necessary to temporarily close the facility to operations, and demolish existing buildings, structures, and utilities in the Main Treatment Area. Upon completing excavation and shipment of excavated materials for offsite treatment and disposal, the facility would need to be rebuilt, and ICs would be implemented for the facility and offsite areas impacted by affected groundwater.

### **10.3.1 Technical Criteria**

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined in Table 10-1. Alternative 3 is evaluated against these technical criteria in the following subsections. The overall rating is shown in Table 10-2.

#### **10.3.1.1 Performance**

Under Alternative 3, practically all affected soil and LNAPL would be removed for offsite treatment and disposal. MNA would continue to degrade COCs present in groundwater beneath and downgradient from the source area; the source would be eliminated, it is expected that MNA would cause the plume to contract over time after source area removal. This approach would be highly effective in removing COCs from the facility and in reducing contaminant loading to downgradient groundwater. Given that this alternative does not rely on engineering controls to limit the mobility or toxicity of affected media and because it would permanently remove most affected soil and LNAPL from the Arlington facility, the useful life of this alternative would be long.

Under applicable regulations, excavated soil and recovered LNAPL would be treated at a permitted facility to permanently destroy COCs. Residuals remaining after treatment would be disposed of in a secure, appropriately permitted landfill. This would substantially decrease the toxicity and mobility of the COCs present in soils at the facility. Biodegradation and immobilization of COCs in the plume beneath and downgradient from the source area would permanently destroy the constituents, gradually reducing both the toxicity and volume of affected groundwater. This alternative would essentially eliminate LNAPL and affected soil remaining onsite. Based on these considerations, this alternative is rated high for effectiveness, useful life, and reduction in toxicity, mobility, and volume.

#### **10.3.1.2 Reliability**

Alternative 3 does not rely on engineering controls requiring active operation or maintenance. No mechanical equipment would be used for this alternative after excavated soil was removed, and offsite treatment would be performed using facilities designed and permitted for waste materials and soil. Alternative 3 is rated high for both long-term operation and maintenance and for demonstrated and expected reliability.

#### **10.3.1.3 Implementability**

This alternative would require complete demolition of operational facilities in the Main Treatment Area, followed by extensive and highly invasive construction to excavate affected soil and LNAPL. For these reasons, excavation and disposal would be difficult and extremely costly. The groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring for the MNA component. The ICs included in this alternative would

apply to the Arlington facility and affected downgradient groundwater and could be readily implemented.

Given the complexities involved in demolishing existing facilities and excavating affected soil, it is expected that the implementation time for this alternative would be fairly long. However, beneficial results would be obtained immediately upon implementing the alternative.

Based on these considerations, Alternative 3 is rated low for both constructability and implementation time and high for beneficial results time frame.

#### **10.3.1.4 Safety**

Alternative 3 would create substantial safety concerns for demolition and remediation workers. These concerns include potential exposure to dust and other materials during demolition; potential exposure to affected soil, LNAPL, and/or affected groundwater during excavation; and the normal construction safety concerns related to demolition and earthwork using heavy equipment. Additional safety concerns include potential slope failure resulting from the depth of the excavation (up to 35 feet below grade). Transportation of excavated soil and LNAPL to disposal facilities would raise safety concerns along transportation routes for other traffic and for affected communities. This alternative is rated low for safety.

#### **10.3.2 Human Health Criteria**

Alternative 3 is rated low for minimizing short-term exposure to COCs at the facility because of the extensive, invasive construction and long-distance transportation associated with excavation and offsite disposal of soil and LNAPL. The alternative is rated high for minimizing the potential for long-term exposure because most of the COCs in excavated soil and recovered LNAPL would be destroyed during offsite treatment. Remaining COCs in excavated soil would be contained within a secure modern landfill. There would be some potential for long-term human exposure because some affected soils could remain; these potential risks would be addressed by ICs.

#### **10.3.3 Environmental Criteria**

Alternative 3 is rated moderately high for these criteria. While environmental benefits would be realized immediately upon completing implementation, the invasive construction and handling/shipping of contaminated soil and LNAPL could create adverse impacts during implementation. However, the potential for adverse impacts could be mitigated by careful planning and strict management. Long-term beneficial effects would result from the alternative because of removal of affected media from the facility and treatment to destroy COCs before disposal in a secure landfill. If some affected soil could potentially remain beneath buildings and other

structures, there could be some residual environmental risks after implementation of the alternative.

#### **10.3.4 Institutional Criteria**

Alternative 3 is rated low for institutional criteria because it would require closure and demolition of the facility plus extensive and invasive construction for implementation. Demolition and excavation permits would be required to implement this alternative; appropriate designs and precautions would be needed to complete excavation to depths of up to 35 feet without creating unacceptable safety concerns. Mitigation measures would be required to minimize the potential for short-term exposures during implementation. It is expected that this alternative could be implemented in compliance with applicable regulations and standards.

#### **10.3.5 Cost**

The estimated total net present value for this alternative is \$40,413,200. First-year costs incurred from implementation of this alternative would include costs for demolition and reconstruction of the facility for the excavation work, disposal of excavated soil, and implementation of the remediation program and ICs. This alternative also would incur lost opportunity costs for Baxter's lost business because this alternative most likely would cause the loss of the lease term that has 13 more years due, resulting in a loss of business customers who would need to go elsewhere during the shutdown, and human resource costs for loss of employees; however, these opportunity costs have not been estimated and are not included in the total estimated cost or the net present value. Annual costs would include maintenance of ICs and groundwater monitoring for 10 years. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed cost estimate worksheets are included in Appendix C. Given the high estimated cost, Alternative 3 is rated low for cost because it has by far the highest estimated cost of any alternative.

### **10.4 Alternative 4: Enhanced Biodegradation Recirculation System**

This alternative combines in situ bioremediation through groundwater recirculation with active recovery of LNAPL, oxygen infusion, and MNA to provide a comprehensive contaminant containment program near the source area. A Pilot Study in situ bioremediation system was installed in early 2008 as a full-scale pilot test and has been operating for 9 years. This system intercepts groundwater immediately downgradient of the main treatment area using groundwater extraction wells. The extraction wells recirculate the groundwater in situ to an aeration/infiltration trench, which mixes the collected groundwater and aerates it to promote in situ biological degradation of groundwater COCs. The water in the trench then infiltrates, creating a recirculation cell to enhance aerobic biodegradation of groundwater COCs. Groundwater flowing from the recirculation cell undergoes additional biodegradation and MNA in the area downgradient from the

recirculation cell. Oxygen infusers (iSOCs) deployed in downgradient monitoring wells act to stimulate ongoing aerobic biological activity. Mobile LNAPL has been recovered using passive collection systems, with one source area well producing the majority of LNAPL.

To augment the performance of the existing Pilot System, additional extraction and infiltration points (i.e. a recirculation system) within the source area would be installed to enhance degradation of NAPL in the vadose zone and reduce COCs in groundwater. Active LNAPL extraction would replace passive collection systems in higher producing locations (i.e. MW-12).

As discussed in Section 9.1.2, a long-term groundwater monitoring program would be conducted using 31 wells from the existing monitoring well network. This program has been underway since 2008. To evaluate vertical plume capture and control, groundwater samples would be collected from existing nested well pairs along the main axis of the plume. Analytical results would be used to evaluate whether elevated PCP concentrations are bypassing the enhanced bioremediation circulation system at depth and to assess the effectiveness of the iSOCs (enhanced MNA) for the groundwater plume beneath the Northwest Parcel and farther downgradient. Groundwater elevations collected from these well pairs also would allow evaluation of vertical gradients across the facility, including immediately upgradient of the aeration trench. For cost estimating purposes, it is assumed that in approximately 15 years, the number of monitored wells would be reduced to 10 wells sampled annually. The monitoring program would be evaluated regularly to assess whether it is adequate to monitor the protectiveness and performance of the system.

#### **10.4.1 Technical Criteria**

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined in Table 10-1. Alternative 4 is evaluated against these technical criteria in the following subsections. The overall rating is shown in Table 10-2.

##### **10.4.1.1 Performance**

Alternative 4 incorporates an in situ bioremediation system to treat groundwater immediately downgradient of the source area with passive LNAPL recovery and MNA to limit the toxicity and mobility of COCs at and downgradient of the facility. Enhanced aerobic bioremediation has been proven effective for wood-treating sites. Based on the data collected in 9 years of operation of this system as a full-scale pilot test, this bioremediation approach would be effective for the Arlington facility. A combination of skimmer extraction and passive LNAPL recovery would be effective for removal of mobile LNAPL. Extraction and injection of amended groundwater in the source area would enhance the biodegradation rate of vadose zone NAPL and dissolved COCs. MNA would degrade COCs downgradient of the enhanced bioremediation system, but degradation rates would be slow, especially as distance from the bioremediation system increases. Oxygen infusion in these downgradient areas is expected to enhance degradation rates.

Biodegradation of constituents resulting from the enhanced bioremediation system and MNA in the downgradient plume would permanently destroy the constituents, thereby reducing both the toxicity and volume of affected groundwater. The enhanced bioremediation system also would increase biodegradation rates downgradient of the extraction wells because of increased dissolved oxygen in groundwater exiting the recirculation zone and direct oxygen infusion in iSOC wells. The mobility of COCs would decrease because of the hydraulic control and enhanced biodegradation created by the groundwater recirculation wells. There would be a moderate reduction in volume of LNAPL caused by passive recovery. The pilot test has shown that this alternative reduces the toxicity and volume of affected groundwater; it has minor effects on the mobility of COCs, but the groundwater recirculation system increases travel time for groundwater COCs because of the increased residence time in the recirculation cell.

The mechanical components included in this alternative to recover LNAPL and recirculate groundwater are simple, readily available, and proven reliable. The useful life for the wells and trench would be long; the mechanical components would require operator attention, maintenance, and periodic replacement. Given that LNAPL recovery included in Alternative 4 would address only readily mobile LNAPL by passive flow to the collection facilities, LNAPL recovery would not be expected to have a long useful life.

Based on these considerations, this alternative is rated moderately high for effectiveness, useful life, and reduction in toxicity, mobility, and volume.

#### **10.4.1.2 Reliability**

Alternative 4 would require long-term operation and maintenance for reliable operation of the enhanced bioremediation system and the LNAPL recovery system. However, operation and maintenance requirements have been shown in the pilot test to be nominal because the mechanical systems are simple and incorporate minimal rotating and electrical equipment. The only equipment expected to require routine checks and maintenance would be the groundwater recirculation pumps. Submersible well pumps have proven to be highly reliable, but they would require periodic maintenance and replacement after about 15 years of operation. Continued monitoring would be required to confirm the effectiveness of the alternative, but this element is common to all alternatives. Based on these considerations, this alternative is rated moderately high for long-term operation and maintenance.

The enhanced bioremediation system has been applied previously to wood-treating sites; the actual configuration has varied in previous applications because of site-specific design requirements. Aerobic bioremediation of groundwater has been used fairly widely and is known to be reliable at wood-treating sites. Other components of this alternative also have been used reliably at wood-treating sites.

No substantial adverse effects, other than reduction in the rate of biodegradation, would result from failure of the enhanced bioremediation recirculation system. If recirculation pumping fails or is stopped for short times, the effectiveness of the bioremediation system would not be significantly affected. If extraction wells stop operating, system warnings would indicate the shutdown, thereby limiting the duration of shutdowns; however, because of the high hydraulic conductivity of the aquifer, groundwater containing elevated COC concentrations could migrate downgradient following a shutdown. In such occurrences, iSOC infusers may be deployed to enhance biodegradation of the migrated plume. Long-term failure of all recirculation wells would result in reduced treatment effectiveness. No significant adverse effects would result from failure of the LNAPL recovery system other than loss of recovery. The key components of this alternative are all compatible; enhanced bioremediation interfaces seamlessly with MNA. Alternative 4 is rated moderately high for demonstrated and expected reliability.

#### **10.4.1.3 Implementability**

This alternative requires minimal additional construction as the Pilot Study system is already in place. The construction of the source area recirculation system requires the installation of additional extraction wells, infiltration columns, and conduit trenching. Well and infiltration column installation can be done in phases and performed quickly with minimal interference to facility operations. Trenching would require minimal surface disturbance and routed around existing utility lines and structures. The Pilot Study aeration trench is classified as a Class 5 injection well under Washington State regulations and the trench was registered with the state, no permitting was required. Infiltration columns would fall under a similar classification, no additional permitting is anticipated.

The groundwater monitoring program described in Section 9.1.2 is sufficient to provide groundwater quality monitoring for this alternative.

The ICs included in the alternative would apply to the Arlington facility and affected downgradient groundwater and could be readily implemented. Data collected during the pilot study demonstrate that degradation of COCs began shortly after startup of the enhanced bioremediation recirculation system, indicating that beneficial results were attained in a short time frame. Enhanced biological activity occurred within a few weeks after system startup. For these reasons, Alternative 4 is rated high for constructability and implementation time, and moderately low for beneficial results time frame.

#### **10.4.1.4 Safety**

Implementation of Alternative 4 presents minor safety concerns. The primary safety concerns would occur during trenching activities, which involves standard earthwork safety issues in addition to potential exposure to soil affected by COCs at the facility. Recovery of LNAPL presents some

safety concerns for direct contact with the LNAPL and for fire. While there are minor safety concerns associated with maintenance of the recirculation wells and aeration trench, this work has been performed safely by trained workers using appropriate, proven procedures. This alternative is rated moderately high for safety.

#### **10.4.2 Human Health Criteria**

Alternative 4 is rated moderately high for minimizing short-term exposure to COCs at the facility based on the limited extent of invasive construction required for implementation. Operational components of this alternative consist largely of wells, which present only a small potential for short-term exposure. The alternative rates moderately high for minimizing the potential for long-term exposure. Recirculated groundwater would not be pumped over long distances and would remain below grade, providing minimal potential for exposure. There would be some potential for human exposure caused by the recovery of LNAPL and maintenance of the recirculation system, but this potential would be limited to facility personnel and can be readily mitigated by using appropriate safety procedures. The active and fairly rapid degradation of COCs by enhanced bioremediation would limit the potential for long-term exposure to COCs at the facility.

#### **10.4.3 Environmental Criteria**

Alternative 4 is rated moderately high for these criteria because pilot study results demonstrated that this alternative would provide short-term beneficial effects and would provide long-term beneficial effects with minimal adverse effects. Furthermore, results of the pilot test have shown that the recirculation wells effectively intercept contaminated groundwater. Aeration of the recirculated groundwater has enhanced biological activity downgradient of the source area. Long-term adverse effects would be limited to non-recoverable LNAPL, affected soil, and affected groundwater remaining beneath the Main Treatment Area; these would not create any significant environmental impacts because the affected media are located beneath an active industrial facility.

#### **10.4.4 Institutional Criteria**

Alternative 4 is rated high for institutional criteria because it does not require extensive, invasive construction for implementation and had limited effects on site activities and facilities during implementation. Future construction, which would consist primarily of rehabilitation of the existing aeration trench or replacement of wells, could be readily coordinated with ongoing facility operations. This alternative has been designed to comply with applicable regulations, including the RCRA regulations. Standard excavation and building permits were needed, but no extensive or complex permitting was required to implement this alternative. The aeration trench is already registered as a Class 5 injection well under Washington State regulations, and is exempt from permitting.

#### **10.4.5 Cost**

The estimated total net present value for this alternative is \$4,900,700. This total net present value cost does not include approximately \$1.2 million in costs incurred by Baxter between 2007 and 2016 for installation and operation of the pilot system. In the cost estimate presented in this CMS, the four years associated with this alternative would include program implementation costs for the design study and construction of the proposed source area biodegradation system. Estimated costs also include modifications and improvements (e.g. pump replacement, etc.) to the existing recirculation system. Annual operation and maintenance costs would include maintenance of ICs, LNAPL recovery and disposal, groundwater monitoring, and operation and maintenance of the recirculation system for 100 years. There would be little or no business interruption costs associated with this alternative. A summary of total estimated costs for this alternative is included in Table 10-3. The detailed cost estimate for Alternative 4 is presented in Appendix C. This alternative is rated moderately high for cost.

### **10.5 Alternative 5: ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation**

This alternative combines ERH, total fluids recovery, enhanced biodegradation recirculation, and ICs to provide a comprehensive contaminant reduction program in the source area. ERH and total fluids recovery would be conducted in the source area (Figure 9-5). Total fluids extraction would recover LNAPL and would provide hydraulic containment of the source area. This potentially feasible combination of remediation technologies would provide an aggressive approach to both LNAPL recovery and soil and groundwater remediation. As described above in Alternative 1, ICs to limit potential direct exposure to affected groundwater and/or soil would be implemented under this alternative. As described in Section 9.1.2, a long-term groundwater monitoring program would be conducted, including semiannual sampling with laboratory analysis for site COCs. The monitoring program would assess whether natural attenuation is actively degrading COCs and assess progress toward attainment of remediation objectives. A subset of the existing monitoring wells would be used for monitoring.

#### **10.5.1 Technical Criteria**

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined in Table 10-1. Alternative 5 is evaluated against these technical criteria in the following subsections. The overall rating is shown in Table 10-2.

##### **10.5.1.1 Performance**

Alternative 5 would provide a comparatively rapid reduction in the toxicity and volume of COCs, particularly in the source area. However, the woodwaste area would not be directly treated by ERH

and, therefore, would be only indirectly treated (as some mass would be removed indirectly because of ERH vapor recovery systems). This alternative should reduce the contaminant loading to the downgradient portion of the plume, which would improve the rate of COC degradation. Potential risks to downgradient receptors would be minimal, based on the limited future mobility of COCs resulting from the combination of remediation technologies applied in this alternative.

Source control would be included to remove LNAPL and highly contaminated groundwater, thereby reducing the toxicity, mobility, and volume of affected media and accelerating cleanup. Recovered groundwater would be treated to permanently destroy dissolved COCs.

Total fluids recovery is used to recover both LNAPL and contaminated groundwater. Given that groundwater would be recovered in the immediate vicinity of the LNAPL, it is likely that more highly contaminated groundwater with incidental amounts of LNAPL would be recovered compared to pumping downgradient of the source area, providing more contaminant mass recovery. Recovered COCs would be removed as a result of groundwater treatment and LNAPL disposal.

The engineering systems, included to facilitate ERH and to recover vapor, LNAPL, and groundwater, are proven technologies, but would require periodic operator attention and maintenance to operate effectively. The useful life for the total fluids recovery system is typical for mechanical systems. Major mechanical components likely would require replacement after 3 to 5 years of operation; however, for ERH only 6 months of active treatment are estimated.

Mobility of COCs would be limited because of the ERH application producing steam and contaminant vapors and by the hydraulic containment created by the operation of the total fluids recovery wells. By inhibiting high-concentration COCs to migrate downgradient and using total fluids recovery to remove contaminant mass, this alternative is expected to result in the cut-off of the downgradient plume ultimately resulting in the contraction of the groundwater plume's leading edge through dilution and degradation of the plume. If fluid recovery pumping were to fail, system warnings would indicate the malfunction; given the high hydraulic conductivity of the aquifer, system effectiveness would decrease shortly after a shutdown, and source area groundwater containing elevated COC concentrations could migrate downgradient of the remediation system.

In addition to total fluids extraction and treatment for an approximately 1 year, the existing enhanced groundwater recirculation system located downgradient from the source area would remain operational for approximately 5 years from implementing the ERH treatment. This system also would capture any increase in COC concentrations in groundwater during and shortly after treatment. After the 5-year period, the recirculation system would be turned off, and monitoring of groundwater conditions would continue for an additional 15 years.

Based on the above considerations, this alternative is rated both high for effectiveness and reduction in the toxicity, mobility, and/or volume of affected media, and moderately high for useful life because of its relatively short time for treatment.

#### **10.5.1.2 Reliability**

Alternative 5 would incorporate one mechanical system (the total fluids system) and one electrical system (ERH) for corrective action, with moderately high operational and maintenance requirements. The total fluids recovery and the groundwater treatment systems would require periodic operator attention for proper operation. Given that both systems would include rotating equipment, regular maintenance would be necessary. The groundwater treatment process required to operate the total fluids system also would require operator attention and regular monitoring so that requirements are attained and that the GAC units are replaced as needed. The ERH system would require periodic operator attention for proper operation and to ensure the temperature ranges are within acceptable operating parameters. However, because the ERH and total fluids recovery system are planned to be in operation for only 6 months, this alternative is rated high for long-term operation and maintenance.

Both thermal heating and total fluids recovery have been proven appropriate for remediation of wood-treating sites. However, both components rely on mechanical and electrical equipment to provide remediation; equipment can fail, and failure of the equipment would render this alternative ineffective for short time periods. However, the relatively short operating time necessary for the system changes makes failure unlikely; thus, this alternative is rated moderately high for demonstrated and expected reliability.

#### **10.5.1.3 Implementability**

This alternative would require fairly extensive construction to install the ERH/fluid recovery wells and conveyance piping, and likely would cause major disturbance of onsite operations. Construction would require detailed coordination with ongoing facility operations. Existing infrastructure and utility lines are present near the source area, which may require re-routing to adequately treat all source material. For these reasons, construction would require careful planning and onsite management so that it is done safely and properly. Constructability for this alternative would be moderately difficult, and the implementation time could vary depending on potential infrastructure changes. Design likely would be in the range of 6 to 12 months.

The long-term groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring for the ERH system.

Implementing this alternative would require disposal of treated groundwater in accordance with applicable regulations. For this CMS, it is assumed that treated groundwater would be discharged

to the subsurface through the ERH/fluid recovery wells. Subsurface injection of the treated groundwater would require appropriate permitting and onsite treatment would require either a RCRA Part B permit, a permit waiver, or a permit-by-rule determination.

The ICs included in this alternative could be readily applied to the facility and affected downgradient groundwater. It is expected that beneficial results would be attained in a comparatively short time frame. For these reasons, Alternative 5 is rated moderately low for constructability and for implementation time. Once implemented, the beneficial results would occur within a short time frame.

#### **10.5.1.4 Safety**

Alternative 5 could be implemented with moderately high concerns for safety. ERH could create some safety concerns, depending on existing utility infrastructure at the facility, considering the reliance on electricity and electrodes for heating the subsurface. There is an area of wood debris/chips in the northern edge of the source area to depths ranging from zero to 15 bgs. This area could create some safety concerns because of the potential for a fire; however, electrodes and heating are intended to be focused beneath this area and monitored by temperature monitoring points. Recovery of LNAPL also could create some safety concerns for direct contact with the LNAPL and for fire. Safety concerns would result from operation of a groundwater treatment system with contaminated groundwater mixed with LNAPL in above-grade piping and vessels. This alternative is rated moderately low for safety.

#### **10.5.2 Human Health Criteria**

Alternative 5 is rated moderately low for minimizing short-term exposure to COCs at the facility because minimal invasive construction work is needed for implementation. There is some potential for human exposure, related to recovery of LNAPL and the associated operation and maintenance activities for the total fluids recovery systems. This alternative is rated high for minimizing long-term exposure because it contributes to active degradation of the majority of COCs and to aggressive recovery of LNAPL.

#### **10.5.3 Environmental Criteria**

Alternative 5 is rated high for these criteria because it would rapidly reduce COCs near the source area, and aggressively recover LNAPL. Minimal short-term effects (adverse or beneficial) would result from implementation of this alternative because only minimally invasive construction would be necessary within affected media. Additionally, containment systems for vapor and liquid would minimize any chance of causing a spike in downgradient concentrations. Long-term beneficial effects would occur comparatively rapidly.

#### **10.5.4 Institutional Criteria**

Alternative 5 is rated moderately low for institutional criteria because it may be difficult to obtain necessary permissions for discharge of treated groundwater and to address RCRA permitting requirements. Discussions with the City of Arlington indicated that the local POTW may not have the capacity to accept the anticipated flow rate of treated groundwater on a short-term or long-term basis. There are also several permitting and administrative impediments related to the surface discharge. For this CMS, it was assumed that treated groundwater would be discharged to the subsurface through the ERH/fluid recovery wells. Additionally, construction of the electrodes/wells and systems needed for the total fluids groundwater/LNAPL recovery and treatment system could interfere with ongoing facility operations, even with detailed planning and coordination with the facility.

#### **10.5.5 Cost**

The estimated total net present value for this alternative (based on the assumptions used for estimation) is \$4,259,100. However, the cost potentially could be much higher if treated groundwater could not be disposed of via onsite infiltration or at the local POTW; if it is necessary to transport the treated water for disposal at another POTW, it could increase annual costs by \$1 million, which would substantially increase the net present value. Infrastructure changes or utility re-routing also are not included in this cost estimate. First-year costs associated with this alternative would include costs to install 103 electrodes/total fluid recovery wells, electrical infrastructure, 6 temperature monitoring points, a groundwater treatment system, and piping plus program costs and costs to implement ICs. Annual costs would include maintenance of ICs, and groundwater monitoring for 20 years. Business interruption and loss of lease income also could substantially increase the cost over the stated estimate. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed estimate worksheets are included in Appendix C. This alternative is rated moderately high for cost because the cost is considerably less than Alternative 3.

### **10.6 Alternative 6: Chemical Oxidation and Enhanced Biodegradation Recirculation**

Alternative 6 would provide a comprehensive contaminant reduction program in the source area with minimal disturbance to onsite operations. ICs would be enforced to limit potential exposure to any remaining COCs in the source area. Injection of oxidant would be performed via push probe drill rig for three separate events, as shown in Figure 9-6. Long-term effectiveness would be monitored via a subset of groundwater monitoring wells.

### **10.6.1 Technical Criteria**

The evaluation for technical criteria includes an assessment of the performance, reliability, implementability, and safety, as defined in Table 10-1. Alternative 6 is evaluated against these technical criteria in the following subsections. The overall rating is shown in Table 10-2.

#### **10.6.1.1 Performance**

Alternative 6 would rely on the ability of oxidant to make contact with COCs in the source area. If successful contact were made, COC concentrations would be reduced. However, chemical oxidation would not be effective in places where background oxidant demand is high (e.g., in woodwaste backfill, high dissolved metals in groundwater, etc.) and could not be injected too close to ground surface without risking surfacing of the oxidant. The soil matrix onsite generally has allowed push probes to reach the target depths, but some probe locations have been limited to shallower depths. In addition, injection could be physically limited if chemical reactions occur and plug the pore space before complete injection of the required oxidant volume. Pilot testing would be needed to confirm that oxidant injection volumes can be met and whether oxidant can be delivered in sufficient concentrations to meet treatability study criteria.

Based on the above considerations and the results of the 2013 bench scale treatability study, this alternative is rated moderately low for effectiveness. The moderately low rating is given because of the high oxidant demand demonstrated by bench scale testing and uncertainty in the success of in situ applications. A corresponding ranking of moderately low is given for reduction in the toxicity, mobility, and/or volume of affected media. Alternative 6 is rated moderately high for useful life because of its relatively short time for application.

#### **10.6.1.2 Implementability**

This alternative would require fairly minor construction, with major equipment consisting of a drill rig and mix tank. Implementing this alternative would require disposal of small amounts of solid and liquid waste from push probe cores. Construction would minimally impact facility operations. The constructability rating for this alternative is moderately high, and the implementation time would be fairly short, likely in the range of 3 to 7 months. This alternative also has a high degree of flexibility in implementation because a phased approach for treatment could be used in conjunction with groundwater monitoring to verify effectiveness after individual treatments.

The long-term groundwater monitoring program described in Section 9.1.2 would be sufficient to provide groundwater quality monitoring after chemical oxidation treatment.

The ICs included in this alternative could be readily applied to the facility and affected downgradient groundwater. It is expected that beneficial results would be attained in a comparatively short time frame if oxidant proves effective in situ for Alternative 6. For these

reasons, Alternative 6 is rated high for implementation time and moderately high for beneficial results time frame.

#### **10.6.1.3 Safety**

Minor safety concerns would result from implementation of Alternative 6. These concerns would affect remediation workers and onsite production workers. Safety concerns include potential exposure to affected soil during drilling, potential exposure to LNAPL or affected groundwater during drilling, and the normal construction safety concerns related to construction using heavy equipment. Additional safety concerns specific to chemical oxidation include potential exposure to chemical oxidant. Safety issues resulting from oxidant exposure can be mitigated by choosing an oxidant that is safe to handle. Regenox requires mixing two inert ingredients to create the oxidant, and, therefore, handling risks are negligible. Risks of the oxidant surfacing have been minimized by limiting injection to 10 feet bgs. Long-term operation and maintenance of the enhanced recirculation system would be required as well as long-term groundwater monitoring. Long-term maintenance and monitoring activities present minimal safety concerns. This alternative is rated moderately high for safety.

#### **10.6.2 Human Health Criteria**

Alternative 6 is rated moderately high for minimizing short-term exposure to COCs at the facility because push probe drilling is the major construction activity. The alternative is rated moderately high for minimizing the potential for long-term exposure because COC mass would be destroyed in situ in the short term and the remainder would be managed by the enhanced recirculation system.

#### **10.6.3 Environmental Criteria**

Alternative 6 is rated moderately high for these criteria because of the destruction of the COC mass in a short time frame and long-term hydraulic control. Some short-term adverse effects could result from implementation of this alternative (such as mobilization of some COCs), but the potential for these effects is minimal. Implementation of this alternative would assist in achieving many remedial objectives, but incomplete source mass removal would require long-term hydraulic controls. Long-term beneficial effects simply would be a function of less COC mass being present. No long-term adverse effects are expected. A majority of the COC mass in the source area would remain (e.g. woodwaste backfill areas would not be directly treated) and, as a result, the beneficial effects would be roughly equivalent to enhanced biological treatment.

#### **10.6.4 Institutional Criteria**

Alternative 6 is rated moderately high for institutional criteria because it would require extensive, but minimally disruptive, construction work for implementation. Injection points would be minimally limited by the presence of existing structures, including buildings, drip pads, rail lines, and treated

pole storage areas. Permitting concerns would be relatively minor because little waste would be generated by this method, and no waste would be treated ex situ onsite.

#### **10.6.5 Cost**

Assuming that the pilot test confirms design expectations, the estimated total net present value for this alternative is approximately \$10,688,400. The cost would be significantly higher if the pilot test shows that even low COC mass areas require multiple injections for effective treatment, or if push probe drilling is slower than expected. Implementation costs associated with this alternative would include costs for drilling, oxidant chemicals, mixing, and disposal of drilling cores, long-term operation of the recirculation system, and minor cost for implementation of ICs. Annual costs would include maintenance of ICs, recirculation system, and groundwater monitoring for 20 to 100 years. Relatively minor impacts on business operations would occur with this alternative. A summary of total estimated costs for this alternative is included in Table 10-3. Detailed cost estimate worksheets are included in Appendix C. This alternative is rated moderately low for cost, based on the fact that it would be one of the more expensive alternatives as measured by net present value cost.

## **11.0 Comparative Evaluation of Corrective Measures Alternatives**

This section compares the corrective measures alternatives that have been developed and evaluated for the Arlington facility. This comparative analysis will be used to select the preferred corrective measures alternative for the facility.

As discussed in Section 10, EPA guidance (EPA, 1994 and 1996) describes two sets of criteria for evaluating corrective measures alternatives: (1) threshold criteria that must be attained by the corrective measures selected for implementation; and (2) balancing criteria that are used for detailed evaluation and screening of alternatives.

Section 10 defined the balancing criteria used in this CMS and evaluated each alternative for its performance relative to the balancing criteria. All corrective measures were designed to attain the threshold criteria; however, the alternatives may differ in how well they achieve these threshold criteria.

Section 11 presents a comparative evaluation of the corrective measures alternatives described in Section 9, consistent with the AOC (EPA, 2001). Separate comparative evaluations are presented for the threshold criteria (Section 11.1) and the balancing criteria (Section 11.2). These comparative analyses are combined to develop a preferred corrective measures alternative in Section 11.3.

### **11.1 Comparative Evaluation: Threshold Criteria**

EPA CMS guidance has established four threshold criteria that must be attained by a selected remedy:

1. Protect human health and the environment.
2. Attain media cleanup standards.
3. Control source areas to reduce or eliminate, to the extent practicable, further releases of hazardous constituents that may pose a threat to human health and the environment.
4. Comply with applicable standards for waste management.

All six corrective measures alternatives considered would attain the threshold criteria. However, some alternatives may require a longer time period to attain the criteria than others. Table 11-1 rates the alternatives from 1 (low) to 4 (high) for relative effectiveness in attaining each threshold

criterion. Equal weighting was used for the threshold criteria evaluation. Table 11-1 also shows the total scores and rankings.

Alternative 3, including excavation and offsite disposal, would provide the most complete and rapid removal of COCs, eliminate most of the source area and future releases, and is ranked highest overall. It scored high for the first three criteria, but moderately low for criterion 4, compliance with waste management standards, because of the large quantity of waste that would be generated and the requirement for treatment to achieve compliance.

Alternative 4 is rated higher than Alternatives 5 and 6 because it has demonstrated effective containment of site contaminants with minimal waste generation. Alternative 5 addresses source area NAPL more aggressively compared to Alternative 4, but generates health and safety concerns in implementation while facility operations are ongoing and underground utilities are in use. Alternative 6 employs existing infrastructure used in Alternative 4, but source area treatment has demonstrated limited potential for success.

Alternatives 5 and 6 received the same overall threshold criteria score. Alternatives 5 and 6 both would actively address source material, but Alternative 6 would provide limited mass reduction in comparison. Conversely, Alternative 5 would require greater quantities of waste to be treated and require substantial infrastructure alterations to implement safely. Both of these alternatives would immediately treat source area, but likely would rely on existing enhanced biodegradation recirculation for treatment of any remaining COCs.

Alternatives 1 and 2 received close to the same overall threshold criteria score. These alternatives both would use active measures that would require significant long-term operations and maintenance. However, the maintenance would be fairly straightforward and none of the measures would be technically challenging to implement or challenging from a regulatory perspective. Alternatives 1 and 2 are the lowest ranked alternatives because compliance with waste management standards would be uncertain given the high level of difficulty in treating and disposing of recovered groundwater.

Table 11-1 shows the ranking of the alternatives based on the total threshold criteria scores from 1 (best) to 6 (worst). The rankings are as follows:

1. Alternative 3 (Excavation, Off-Site Disposal, and MNA)
2. Alternative 4 (Enhanced Biodegradation Recirculation System)
3. Alternative 5 (ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation)
3. Alternative 6 (Chemical Oxidation and Enhanced Biodegradation Recirculation)

5. Alternative 1 (Total Fluids Recovery, Air Sparging, and MNA)
6. Alternative 2 (Physical/Hydraulic Containment and MNA)

## **11.2 Comparative Evaluation: Balancing Criteria**

This section compares the six corrective measures alternatives for the balancing criteria. The balancing criteria identified in the AOC have been separated into technical criteria, human health criteria, environmental criteria, institutional criteria, and cost. The technical criteria have been further subdivided into criteria related to performance, reliability, implementability, and safety. All of the balancing criteria used in this CMS are defined in Table 10-1 and in the CMS guidance (EPA, 1996). EPA's AOC (EPA, 2001) has established a slightly different and more detailed set of balancing criteria that must be followed for this CMS, as described in Section 10.

Each alternative was evaluated against the balancing criteria and assigned a numerical rating in Section 10 (Table 10-2). A total score was calculated from these numerical ratings and used to rank the six corrective measures alternatives from 1 (highest) to 6 (lowest) (Table 11-2).

The ranking is based on the total scores shown in Table 10-2 and Table 11-1. The overall relative ranking of the six alternatives based on the balancing criteria is presented in Table 11-2. The highest ranked alternative is Alternative 4, and the lowest ranked alternatives are Alternative 1 and Alternative 2.

## **11.3 Summary of Alternatives**

The relative rankings for the threshold criteria and the balancing criteria are summarized in Table 11-2. The final column in Table 11-2 shows the rankings based on the total of scores for threshold and balancing criteria, assigning equal weighting to the two sets of criteria. In Table 11-2, the lowest total score results in the highest ranking. This equal weight approach is consistent with requirements set forth in EPA guidance documents for CMSs (EPA, 1994 and 1996).

The combined ranking for the alternatives, including both threshold and balancing criteria, is shown in Table 11-2. The four highest-ranked alternatives are:

- Alternative 4 (Enhanced Biodegradation Recirculation System) is ranked highest.
- Alternative 3 (Excavation, Off-Site Disposal, and MNA) and Alternative 5 (ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation) are tied for second highest.
- Alternative 6 (Chemical Oxidation and Enhanced Biodegradation Recirculation) is ranked as the fourth highest.

As shown in Table 11-2, for the threshold criteria, Alternative 3 is ranked highest and Alternative 4 is ranked second. For the balancing criteria, Alternative 4 is ranked highest and Alternative 5 is ranked second.

Of the four highest-ranked alternatives, Alternative 3 would be the most rapid and most reliably effective option for removing COC mass, but has a disproportionately high cost relative to the other alternatives considered in this CMS. In addition, Alternative 3 would have the most severe impact on facility operations and would be the least implementable of the alternatives.

Alternative 6 could be synergistic with the current and recommended site remedy, but has proven uncertain during site investigations as to the level of success if implemented. In light of treatability study results, Alternative 6 may require that significant quantities oxidant to be injected to minimally affect source mass material. While some source contaminants would be removed, the alternative ultimately would depend on existing treatment systems and long-term treatment.

Alternative 5 could rapidly remove COC mass in the source area, but would provide many uncertainties in implementability that Alternatives 4 does not. For Alternative 5, additional investigations would be required to delineate the edges of residual NAPL in the treatment area to optimize the number and configuration of electrodes in the subsurface; bench-scale tests on soils from the source areas would be required to establish optimal heating times and COC destruction efficiencies. Safety concerns related to installation amongst existing site infrastructure would need to be addressed before design or implementation of Alternative 5. Additional risks are associated with this alternative because of possible mobilization of COCs offsite.

The combined ranking for Alternative 4 is the highest of all six alternatives. The evaluations and rankings developed in this CMS are based on EPA guidance and the AOC. Alternative 4 would control and treat COCs released from residual LNAPL and affected soil in the source area. This alternative is currently active at the facility as part of the pilot remediation system, and monitoring data indicate that the existing plume is decreasing in area and concentration with time, although the restoration time frame would be much longer than other alternatives. Expansion of the bioremediation system with the construction of a source area recirculation system would act to reduce source mass and reduce the restoration timeline. The initial installation costs for this alternative are estimate to be \$0.9 million in addition to the pilot remediation system costs, which have already been incurred and are not included in the cost estimates presented in Table 10-3 and Appendix C. Overall, this alternative would provide the most effective treatment and management of site contaminants. Based on the analysis presented in this CMS, Alternative 4 is Baxter's preferred remedy.

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## **13.0 Limitations**

This report was prepared exclusively for Baxter and EPA. The quality of information, conclusions, and estimates contained herein are based on: (1) information available at the time of preparation, (2) data supplied by outside sources, and (3) the assumptions, conditions, and qualifications set forth in this report. This CMS, Revision 4, is intended to be used by Baxter and EPA for the former wood-treating facility in Arlington, Washington, only. Any other use of, or reliance on, this report by any third party is at that party's sole risk.



## **TABLES**

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TABLE 3-1

**PROPOSED CLEANUP LEVELS FOR GROUNDWATER<sup>1, 2</sup>**

Former J.H. Baxter & Co. Wood Treating Facility  
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

	MTCA Method A	MTCA Method B		Maximum Contaminant Level	EPA RSL, Tap Water	Proposed Cleanup Level
		Carcinogen	Non- Carcinogen			
Metals						
Arsenic	5	0.058	4.8	10	0.045	10
Barium	--	--	3,200	2,000	2,900	2,000
Cadmium	5	--	16	5	6.9	5
Calcium	--	--	--	--	--	--
Chromium	50	--	--	100	--	100
Copper	--	--	640	1,300	620	1,300
Iron	--	--	--	--	11,000	11,000
Lead	15	--	--	15	--	15
Magnesium	--	--	--	--	--	--
Manganese	--	--	2,240	--	320	2,240
Nickel	--	--	320	--	300	320
Potassium	--	--	--	--	--	--
Selenium	--	--	80	50	78	50
Sodium	--	--	--	--	--	--
Zinc	--	--	4,800	--	4,700	4,800
Total Petroleum Hydrocarbons						
Diesel Range Organics (DRO)	500	--	--	--	--	500
Residual Range Organics (RRO)	500	--	--	--	--	500
Phenols						
2,4,6-Trichlorophenol	--	4.0	--	--	3.5	4.0
2,3,4,5-Tetrachlorophenol	--	--	--	--	--	--
2,3,5,6-Tetrachlorophenol	--	--	480	--	170	480
Pentachlorophenol	--	0.22	80	1.0	0.035	1.0
Polycyclic Aromatic Hydrocarbons						
2-Methylnaphthalene	--	--	32	--	27	32
Acenaphthene	--	--	960	--	400	960
Acenaphthylene	--	--	--	--	--	--
Anthracene	--	--	4,800	--	1,300	4,800
Benzo(a)anthracene	--	-- <sup>3</sup>	--	--	0.029	-- <sup>3</sup>
Benzo(a)pyrene	0.1	0.012	--	0.2	0.0029	0.2
Benzo(b)fluoranthene	--	-- <sup>3</sup>	--	--	0.029	-- <sup>3</sup>
Benzo(g,h,i)perylene	--	--	--	--	--	--
Benzo(k)fluoranthene	--	-- <sup>3</sup>	--	--	0.29	-- <sup>3</sup>
Chrysene	--	-- <sup>3</sup>	--	--	2.9	-- <sup>3</sup>
Dibenz(a,h)anthracene	--	-- <sup>3</sup>	--	--	0.0029	-- <sup>3</sup>
Fluoranthene	--	--	640	--	630	640
Fluorene	--	--	640	--	220	640
Indeno(1,2,3-cd)pyrene	--	-- <sup>3</sup>	--	--	0.029	-- <sup>3</sup>

TABLE 3-1

**PROPOSED CLEANUP LEVELS FOR GROUNDWATER<sup>1, 2</sup>**

Former J.H. Baxter & Co. Wood Treating Facility  
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

	MTCA Method A	MTCA Method B		Maximum Contaminant Level	EPA RSL, Tap Water	Proposed Cleanup Level
		Carcinogen	Non- Carcinogen			
Polycyclic Aromatic Hydrocarbons (continued)						
Naphthalene	160	--	160	--	0.14	160
Phenanthrene	--	--	--	--	--	--
Pyrene	--	--	480	--	87	480
Volatile Organic Compounds						
m,p-xylenes	1,000	--	1,600	10,000	190	10,000
o-xylene	--	--	16,000	10,000	190	10,000
Trichlorofluoromethane	--	--	2,400	--	1,100	2,400
Dioxins/Furans						
Dioxins/Furans as 2,3,7,8-TCDD TEQ	--	-- <sup>4</sup>	--	3.00E-05	5.20E-07	3.00E-05

Notes

1. Includes all constituents detected at least once based on Table 8-5 of the Site Investigation Report (Baxter, 2005a).
2. -- = No cleanup level available.
3. Value is calculated using TEF as total cPAHs and compared to the value for benzo(a)pyrene according to WAC 173-340-708(8)(e).
4. Value is calculated using TEF as total dioxins/furans and compared to the value for 2,3,7,8-TCDD according to WAC 173-340.

Abbreviations

2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin  
 EPA = U.S. Environmental Protection Agency  
 MTCA = Model Toxics Control Act  
 RSL = Regional Screening Level (2012)  
 TEF = toxicity equivalent factor  
 TEQ = toxicity equivalent  
 WAC = Washington Administrative Code

TABLE 3-2

**PROPOSED CLEANUP LEVELS FOR SOIL** <sup>1, 2, 3</sup>  
 Former J.H. Baxter & Co. Wood Treating Facility  
 Arlington, Washington

concentrations shown in milligrams per kilogram (mg/kg)

Constituent	MTCA Method A		MTCA C		2012 EPA RSLs				Parcel A Proposed Cleanup Level	Parcel B Proposed Cleanup Level
	Industrial	Unrestricted	Direct Contact	Protection of Groundwater	Industrial	Residential	Risk-Based SSL	MCL-Based SSL		
1,2,4-Trimethylbenzene	--	--	175,000	23.48	260	62	0.021	--	<b>23.48</b>	<b>175,000</b>
1,3,5-Trimethylbenzene	--	--	35,000	7.147	10,000	780	0.12	--	<b>7.147</b>	<b>35,000</b>
2,4,5-Trichlorophenol	--	--	350,000	28.8	62,000	6,100	3.3	--	<b>28.8</b>	<b>350,000</b>
2,4,6-Trichlorophenol	--	--	11,931	0.0464	160	44	0.013	--	<b>0.0464</b>	<b>11,931</b>
2-Methylnaphthalene	--	--	14,000	5.569	2,200	230	0.14	--	<b>5.569</b>	<b>14,000</b>
3,4-Dichlorophenol*	--	--	10,500	0.168	1,800	180	0.041	--	<b>0.168</b>	<b>10,500</b>
Acenaphthene	--	--	210,000	97.93	33,000	3,400	4.1	--	<b>97.93</b>	<b>210,000</b>
Acenaphthylene	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	1,050,000	2,227	170,000	17,000	42	--	<b>2,227</b>	<b>1,050,000</b>
Benz(a)anthracene	--	--	-- <sup>1</sup>	0.2089	2.1	0.15	0.01	--	<b>0.2089</b>	<b>2.1</b>
Benzene	0.03	0.03	2,386	0.02819	5.4	1.1	0.0002	0.0026	<b>0.02819</b>	<b>2,386</b>
Benzo(a)pyrene	2	0.1	18	3.881	0.21	0.015	0.0035	0.24	<b>3.881</b>	<b>18</b>
Benzo(b)fluoranthene	--	--	-- <sup>1</sup>	0.6961	2.1	0.15	0.035	--	<b>0.6961</b>	<b>2.1</b>
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	-- <sup>1</sup>	6.961	21	1.5	0.35	--	<b>6.961</b>	<b>21</b>
Chrysene	--	--	-- <sup>1</sup>	23.21	210	15	1.1	--	<b>23.21</b>	<b>210</b>
Dibenz(a,h)anthracene	--	--	-- <sup>1</sup>	0.1044	0.21	0.015	0.011	--	<b>0.1044</b>	<b>0.21</b>
Dibenzofuran	--	--	3,500	11.66	--	--	--	--	<b>11.66</b>	<b>3,500</b>
Fluoranthene	--	--	140,000	629	22,000	2,300	70	--	<b>629</b>	<b>140,000</b>
Fluorene	--	--	140,000	101.1	22,000	2,300	4	--	<b>101.1</b>	<b>140,000</b>
Indeno(1,2,3-cd)pyrene	--	--	-- <sup>1</sup>	2.03	2.1	0.15	0.2	--	<b>2.03</b>	<b>2.1</b>
Naphthalene	5	5	70,000	4.486	18	3.6	0.00047	--	<b>4.486</b>	<b>70,000</b>
Pentachlorophenol	--	--	328	0.0158	2.7	0.89	0.00036	0.01	<b>0.0158</b>	<b>328</b>
Phenanthrene	--	--	--	--	--	--	--	--	--	--
Pyrene	--	--	105,000	654.7	17,000	1,700	9.5	--	<b>654.7</b>	<b>105,000</b>
Diesel (DRO)	2,000	2,000	--	--	--	--	--	--	<b>2,000</b>	<b>2,000</b>
Residual Oil (RRO)	2,000	2,000	--	--	--	--	--	--	<b>2,000</b>	<b>2,000</b>
Dioxins/Furans (2,3,7,8-TCDD TEQ)	--	--	1.46E-03	2.39E-03	1.80E-05	4.50E-06	2.60E-07	1.50E-05	<b>1.46E-03</b>	<b>1.46E-03</b>

Notes

1. Since groundwater cleanup levels for cPAHs are calculated as a total toxic equivalent, the individual cPAH RSLs were used in the protection of groundwater calculations where an individual MTCA cleanup value was not available.
2. -- = No cleanup level available.
3. \* = cleanup level for 2,4-dichlorophenol was used.

Abbreviations

cPAH = carcinogenic polycyclic  
aromatic hydrocarbons

EPA = U.S. Environmental Protection Agency

MCL = maximum containment level

MTCA = Model Toxics Control Act

RSL = Regional Screening Level (2012)

SSL = soil screening level

TEQ = toxicity equivalent

TABLE 4-1

GROUNDWATER DETECTIONS ABOVE PROPOSED CLEANUP LEVELS<sup>1,2</sup>

Former J.H. Baxter & Co. Wood Treating Facility  
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

Constituent	Proposed Cleanup Level	Highest Detected Concentration			
		Parcel A and Affected Groundwater		Parcel B	
Metals					
Arsenic	10	BXS-3	21.9	BXS-4	5.4
Barium	2,000	BXS-3	71.2	BXS-4	32
Cadmium	5	ND		ND	
Calcium	--	BXS-3	112,000	BXS-4	20300
Chromium	100	--		--	
Copper	1,300	BXS-2	5.2	ND	
Iron	11,000	BXS-3	21,900	MW-14	2050
Lead	15	--		--	
Magnesium	--	BXS-2	71,200	BXS-4	8490
Manganese	2,240	BXS-3	17,900	BXS-4	127
Nickel	320	BXS-2	41	ND	
Potassium	--	BXS-2	12,300	BXS-4	3000
Selenium	50	--		--	
Sodium	--	MW-10	62,100	BXS-4	7270
Zinc	4,800	BXS-3	20	ND	
TPH					
Diesel Range Organics	500	MW-13	3,700	BXS-4	87
Residual Range Organics	500	MW-13	66	ND	
Phenols					
2,4,6-Trichlorophenol	4	ND		ND	
2,3,4,5-Tetrachlorophenol	--	ND		--	
2,3,5,6-Tetrachlorophenol	480	MW-3	110	--	
Pentachlorophenol	1	MW-13	19,000	BXS-4	0.62
PAHs					
2-Methylnaphthalene	32	MW-3	1.3	MW-14	0.02
Acenaphthene	960	MW-13	9.6	ND	
Acenaphthylene	--	MW-13	0.5	ND	
Anthracene	4,800	MW-13	1.2	MW-14	0.0018
Benzo(a)anthracene	--	MW-13	0.1	MW-14	0.0082
Benzo(a)pyrene	0.2	MW-15	0.025	MW-14	0.0031
Benzo(b)fluoranthene	--	MW-15	0.056	MW-14	0.0042
Benzo(g,h,i)perylene	--	MW-3	0.017	MW-14	0.0072
Benzo(k)fluoranthene	--	MW-13	0.018	MW-14	0.0033
Chrysene	--	MW-13	0.1	MW-14	0.0057
Dibenz(a,h)anthracene	--	MW-3	0.015	MW-14	0.0058
Fluoranthene	640	MW-13	0.77	MW-14	0.0031

TABLE 4-1

**GROUNDWATER DETECTIONS ABOVE PROPOSED CLEANUP LEVELS<sup>1,2</sup>**

Former J.H. Baxter & Co. Wood Treating Facility  
Arlington, Washington

concentrations shown in micrograms per liter (µg/L)

Constituent	Proposed Cleanup Level	Highest Detected Concentration			
		Parcel A and Affected Groundwater		Parcel B	
PAHs (continued)					
Fluorene	640	MW-13	8.7	MW-14	0.0044
Indeno(1,2,3-cd)pyrene	--	MW-3	0.012	MW-14	0.0057
Naphthalene	160	MW-3	5.4	MW-14	0.0037
Phenanthrene	--	MW-3	0.035	ND	
Pyrene	480	MW-13	0.61	MW-14	0.0036
VOCs					
m,p-xylenes	10,000	--		--	
o-xylene	10,000	--		--	
Trichlorofluoromethane	2,400	--		--	
Dioxins/Furans					
Dioxins/Furans as 2,3,7,8-TCDD TEQ	3.00E-05	MW-1	2.40E-05	ND	

Notes

- Table is based on data collected since 2001.
- = No data available.  
ND = Not detected.  
**Bold** = Concentration is greater than proposed cleanup level.

Abbreviations

PAHs = polycyclic aromatic hydrocarbons  
TEQ = toxicity equivalent  
TPH = total petroleum hydrocarbons  
VOCs = volatile organic compounds

TABLE 4-2

SOIL DETECTIONS ABOVE PROPOSED CLEANUP LEVELS <sup>1,2</sup>Former J.H. Baxter & Co. Wood Treating Facility  
Arlington, Washington

concentrations shown in milligrams per kilogram (mg/kg)

Constituent	Parcel A				Parcel B				
	Proposed Cleanup Level	Highest Surface Soil Concentration		Highest Subsurface Soil Concentration <sup>3</sup>	Proposed Cleanup Level	Highest Surface Soil Concentration		Highest Subsurface Soil Concentration <sup>3</sup>	
1,2,4-Trimethylbenzene	23.48	--		--	175,000	--		--	
1,3,5-Trimethylbenzene	7.147	--		--	175,000	--		--	
2,4,5-Trichlorophenol	28.8	ND		ND	350,000	ND		ND	
2,4,6-Trichlorophenol	0.464	ND		ND	11,931	ND		ND	
2-Methylnaphthalene	5.569	SS25	0.0049	<b>SB-39 (10-12)</b> <b>170</b>	14,000	SS18A	0.00056	SB-59 (4-6)	0.0003
3,4-Dichlorophenol <sup>4</sup>	0.168	ND		SB-36 (14-16) 0.0047	10,500	ND		ND	
Acenaphthene	97.93	SS24	0.00038	<b>SB-39 (10-12)</b> <b>210</b>	210,000	ND		ND	
Acenaphthylene	--	SS02	0.00066	SB-39 (10-12) 2.9	--	SS18A	0.014	ND	
Anthracene	2.227	SS24	0.003	SB-39 (10-12) 95	1,050,000	SS18A	0.026	ND	
Benz(a)anthracene	0.2089	SS14	0.0083	<b>SB-39 (10-12)</b> <b>29</b>	2	SS18A	0.065	SB-59 (4-6)	0.00022
Benzene	0.02819	--		--	2,386	--		--	
Benzo(a)pyrene	3.881	SS14	0.017	<b>SB-39 (10-12)</b> <b>14</b>	18	SS18A	0.13	SB-59 (4-6)	0.00026
Benzo(b)fluoranthene	0.6961	SS24	0.021	<b>SB-39 (10-12)</b> <b>12</b>	2.1	SS18A	0.24	SB-59 (4-6)	0.0013
Benzo(g,h,i)perylene	--	SS24	0.025	SB-39 (10-12) 3.9	--	SS18A	0.11	SB-59 (4-6)	0.00076
Benzo(k)fluoranthene	6.961	SS14	0.013	<b>SB-39 (10-12)</b> <b>14</b>	21	SS18A	0.17	SB-59 (4-6)	0.00055
Chrysene	23.21	SS14	0.049	<b>SB-39 (10-12)</b> <b>29</b>	210	SS18A	0.12	SB-59 (4-6)	0.00064
Dibenz(a,h)anthracene	0.1044	SS05	0.005	<b>SB-39 (10-12)</b> <b>1.2</b>	0.21	SS18A	0.022	ND	
Dibenzofuran	11.66	--		--	3,500	--		--	
Fluoranthene	629	SS14	0.018	SB-39 (10-12) 180	140,000	SS18A	0.0092	ND	
Fluorene	101.1	SS25	0.0011	<b>SB-39 (10-12)</b> <b>190</b>	140,000	ND		ND	
Indeno(1,2,3-cd)pyrene	2.03	SS24	0.021	<b>SB-39 (10-12)</b> <b>5.8</b>	2.1	SS18A	0.12	SB-59 (4-6)	0.00083
Naphthalene	4.486	SS02	0.0072	<b>MW-13 (32-34)</b> <b>35</b>	70,000	SS18A	0.00043	ND	
Pentachlorophenol	0.0158	<b>SS05</b>	<b>4.7</b>	<b>SB-39 (10-12)</b> <b>1,300</b>	328	SS16	0.41	SB-52 (4-6)	0.14
Phenanthrene	--	SS25	0.0085	SB-39 (10-12) 450	--	SS18A	0.0018	ND	
Pyrene	654.7	SS14	0.03	SB-39 (10-12) 130	105,000	SS18A	0.015	SB-59 (4-6)	0.00053
Diesel (DRO)	2,000	<b>SS10</b>	<b>2,100</b>	<b>MW-13 (32-34)</b> <b>45,000</b>	2,000	SS18A	140	MW-14 (4-6)	15
Residual Oil (RRO)	2,000	SS10	1,500	<b>MW-13 (32-34)</b> <b>3,100</b>	2,000	<b>SS20</b>	1,200	<b>SB-57 (4-6)</b>	<b>5,300</b>
Dioxins/Furans (2,3,7,8-TCDD TEQ)	2.388E-03	SS11	6.450E-04	--	1.460E-03	SS21	1.14E-04	--	

## Notes

1. Soil results from Tables 8-1 and 8-2 in the Site Investigation Report (Baxter, 2005a).
2. **Bold** = Concentration is greater than proposed cleanup level.  
ND = not detected.  
-- = No sample analyzed or no cleanup level established.

3. Sample depth in feet is shown in parentheses.
4. Cleanup level for 2,4-dichlorophenol was used.
5. See section 9.3 of text for explanation of corrective measures alternatives for F

**TABLE 9-1**

**CORRECTIVE MEASURES ALTERNATIVES**  
Former J.H. Baxter Co. Wood Treating Facility  
Arlington, Washington

Alternative 1	Total Fluids Recovery, Air Sparging, and MNA
Alternative 2	Physical/Hydraulic Containment and MNA
Alternative 3	Excavation, Off-Site Disposal, and MNA
Alternative 4	Enhanced Biodegradation Recirculation System
Alternative 5	ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation
Alternative 6	Chemical Oxidation and Enhanced Biodegradation Recirculation

**TABLE 10-1**

**CORRECTIVE MEASURES SCREENING CRITERIA**

Former J.H. Baxter and Co. Wood Treating Facility  
Arlington, Washington

Screening Criteria	Definition
<b>Technical Criteria</b>	
<i>Performance</i>	
Effectiveness	Capability for the alternative to perform the intended functions, such as containment or constituent destruction. This criterion must be evaluated through design specification or performance evaluation. Site-specific characteristics that affect the effectiveness of the alternative must be considered.
Useful Life	The length of time that the alternative can achieve its effectiveness. Specific components of an alternative may require replacement at the end of its useful life in order to continue to achieve the desired objective. The availability of resources in the future as well as the appropriateness of the technology must be considered to assess the useful life.
Toxicity, Mobility, and Volume Reduction	Capability of the alternative to remove the constituents from interaction with the environment through treatment. The reductions can be achieved by treatment to destroy COCs, treatment to immobilize the COCs, or treatment to reduce the volume of affected media.
<i>Reliability</i>	
Long-Term Operation & Maintenance Requirements	The frequency and complexity of operations and maintenance procedures and availability of qualified labor. Alternatives requiring frequent or complex procedures would be less reliable than those requiring less frequent or simpler procedures.
Demonstrated and Expected Reliability	Assessment of the risk and potential effects due to failure of the alternative. Factors to assess include success of the technology in previous similar applications, demonstrated compatibility of multiple technologies, effects of failure of one component on other components, and the flexibility of the alternative to deal with uncontrollable changes.
<i>Implementability</i>	
Constructability	Relative ease of implementation for the alternative, considering factors specific to the site and external factors. Site factors could include heterogeneity, utilities or buildings, adjacent properties, natural conditions, etc. External factors could include availability of qualified contractors, permitting requirements, etc.
Implementation Time	Time needed to implement the alternative. Alternatives that can be implemented in a short time would be preferred over those that require longer implementation times.
Beneficial Results Time Frame	Time required to achieve the full effectiveness than others. Alternatives that achieve beneficial results in a shorter time would be preferred over alternatives requiring more time.
<i>Safety</i>	
Risk of Fire, Explosion, or Exposure to Hazardous Substances	Risks posed to workers implementing the corrective measure as well as to nearby businesses and communities. Factors to be assessed for safety include fire, explosion, traffic accidents, potential for exposure to site constituents, and injuries associated with implementation.

**TABLE 10-1****CORRECTIVE MEASURES SCREENING CRITERIA**

Former J.H. Baxter and Co. Wood Treating Facility  
Arlington, Washington

Screening Criteria	Definition
<b>Human Health Criteria</b>	
Minimization of Short- and Long-Term Exposure	The extent to which the alternative mitigates both short-term and long-term exposure to site constituents, including protection of workers and the public during implementation of the alternative. Potential exposure routes, the nature and location of site constituents, and the locations of potentially exposed populations are assessed.
<b>Environmental Criteria</b>	
Short- and Long-Term Beneficial Versus Adverse Effects	The short- and long-term beneficial and adverse effects associated with the alternative owing to site conditions and pathways, including measures taken to mitigate these effects. In addition, the beneficial or adverse effects on environmentally sensitive areas that could be affected by the corrective measure alternative are considered.
<b>Institutional Criteria</b>	
Relative Ease of Addressing Institutional Issues	Compliance with applicable federal, state, and local environmental, safety, or public health standards, guidance, or regulations on the design, operation, or implementation time for the alternative. Community issues that may affect the design, operation, or implementation time of the alternative. For the Arlington facility, which is an active production facility, institutional issues that must be addressed include compatibility with ongoing facility operations and with existing facilities.
<b>Cost</b>	
Relative Cost	The estimated costs for construction and for operation and maintenance of the alternative, including associated monitoring and inspection costs. Total costs in current dollars will be estimated for a project life up to 100 years. All net present value costs based on 2 percent discount factor.

Abbreviations

COCs = constituents of concern

TABLE 10-2

**CORRECTIVE MEASURES COMPARATIVE EVALUATION: BALANCING CRITERIA<sup>1</sup>**

Former J.H. Baxter Co. Wood Treating Facility  
Arlington, Washington

Alternative	Technical									Human Health		Environmental	Institutional	Cost	Total Score	Ranking
	Performance			Reliability		Implementability		Safety								
	Effectiveness	Useful Life	Toxicity, Mobility, and Volume Reduction	Long-term Operation and Maintenance	Demonstrated and Expected Reliability	Constructability	Implementation Time	Beneficial Results Time Frame	Risk of Fire, Explosion, or Exposure to Hazardous Substances	Minimization of Short-Term Exposure	Minimization of Long-Term Exposure	Short- and Long-Term Beneficial vs. Adverse Effects	Relative Ease of Addressing Institutional Issues	Relative Cost		
1 Total Fluids Recovery, Air Sparging, and MNA	3	1	3	1	1	2	2	3	2	3	3	3	2	2	31	5
2 Physical/Hydraulic Containment and MNA	3	2	3	2	2	1	2	3	2	2	3	3	1	2	31	5
3 Excavation, Off-Site Disposal, and MNA	4	4	4	4	4	1	1	4	1	1	4	3	1	1	37	4
4 Enhanced Biodegradation Recirculation System	3	3	3	3	3	3	3	2	3	3	3	3	4	3	42	1
5 ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation	4	3	3	3	3	2	2	4	2	2	4	4	2	3	41	2
6 Chemical Oxidation and Enhanced Biodegradation Recirculation	2	3	2	3	2	3	4	2	3	3	3	3	3	2	38	3

Notes

1. Alternatives are rated for relative effectiveness as High (4), Moderately High (3), Moderately Low (2), or Low (1). Higher scores indicate better performance or effectiveness. Higher scores also indicate lower overall costs. Total score is based on equal weighting for each criterion.

TABLE 10-3

ESTIMATED COSTS FOR CORRECTIVE MEASURES ALTERNATIVES  
Former J.H. Baxter Co. Wood Treating Facility  
Arlington, Washington

Alternative	Initial Cost <sup>1</sup>	Total Cost <sup>2</sup>	Net Present Value <sup>3</sup>
1 Total Fluids Recovery, Air Sparging, and MNA	\$606,400	\$7,792,000	\$5,217,400
2 Physical/Hydraulic Containment and MNA	\$1,526,100	\$7,586,000	\$5,538,200
3 Excavation, Off-site Disposal, and MNA	\$32,541,600	\$40,868,000	\$40,413,200
4 Source Area and Plume Enhanced Biodegradation Recirculation System	\$903,500	\$7,036,000	\$4,900,700
5 Electric Resistance Heating, Recirculation, and MNA	\$2,924,600	\$4,350,000	\$4,259,100
6 Chemical Oxidation, Recirculation, and MNA	\$4,228,600	\$10,015,000	\$8,226,400

Notes

- 1. First year costs for implementation (assumed to be 2017) in 2012 dollars.
- 2. Total cost for project in 2012 dollars.
- 3. Net present value based on a 1.1% discount factor.
- 4. Initial costs for Alternative 4 do not include costs already incurred by Baxter of approximately \$1,200,000 (installation and operations and maintenance).

TABLE 11-1

**CORRECTIVE MEASURES COMPARATIVE EVALUATION: THRESHOLD CRITERIA <sup>1</sup>**

Former J.H. Baxter Co. Wood Treating Facility  
Arlington, Washington

Alternative	Protect Human Health and the Environment	Attain Cleanup Standards	Control Future Hazardous Constituent Releases	Comply with Waste Management Standards	Total Score	Ranking
1 Total Fluids Recovery, Air Sparging, and MNA	2	3	2	2	9	5
2 Physical/Hydraulic Containment and MNA	2	2	2	2	8	6
3 Excavation, Off-Site Disposal, and MNA	4	4	4	2	14	1
4 Enhanced Biodegradation Recirculation System	3	3	3	4	13	2
5 ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation	2	3	3	2	10	3
6 Chemical Oxidation and Enhanced Biodegradation Recirculation	2	2	3	3	10	3

Notes

1. Alternatives are rated for relative effectiveness as high (4), moderately high (3), moderately low (2), or low (1). Higher scores indicate better performance or effectiveness. Total score is based on equal weighting for each criterion.

TABLE 11-2

**RANKING OF CORRECTIVE MEASURES ALTERNATIVES <sup>1</sup>**

Former J.H. Baxter Co. Wood Treating Facility  
Arlington, Washington

<b>Alternative</b>	<b>Threshold Criteria Ranking<sup>2</sup></b>	<b>Balancing Criteria Ranking<sup>3</sup></b>	<b>Combined Score</b>	<b>Combined Ranking</b>
1 Total Fluids Recovery, Air Sparging, and MNA	5	5	10	5
2 Physical/Hydraulic Containment and MNA	6	5	11	6
3 Excavation, Off-Site Disposal, and MNA	1	4	5	2
4 Enhanced Biodegradation Recirculation System	2	1	3	1
5 ERH, Total Fluids Recovery, and Enhanced Biodegradation Recirculation	3	2	5	2
6 Chemical Oxidation and Enhanced Biodegradation Recirculation	3	3	6	4

1. The ranking in this table is based on 1 being the highest and 6 the lowest.

The combined score is the sum of the rankings for individual criteria, and is the basis for combined ranking.

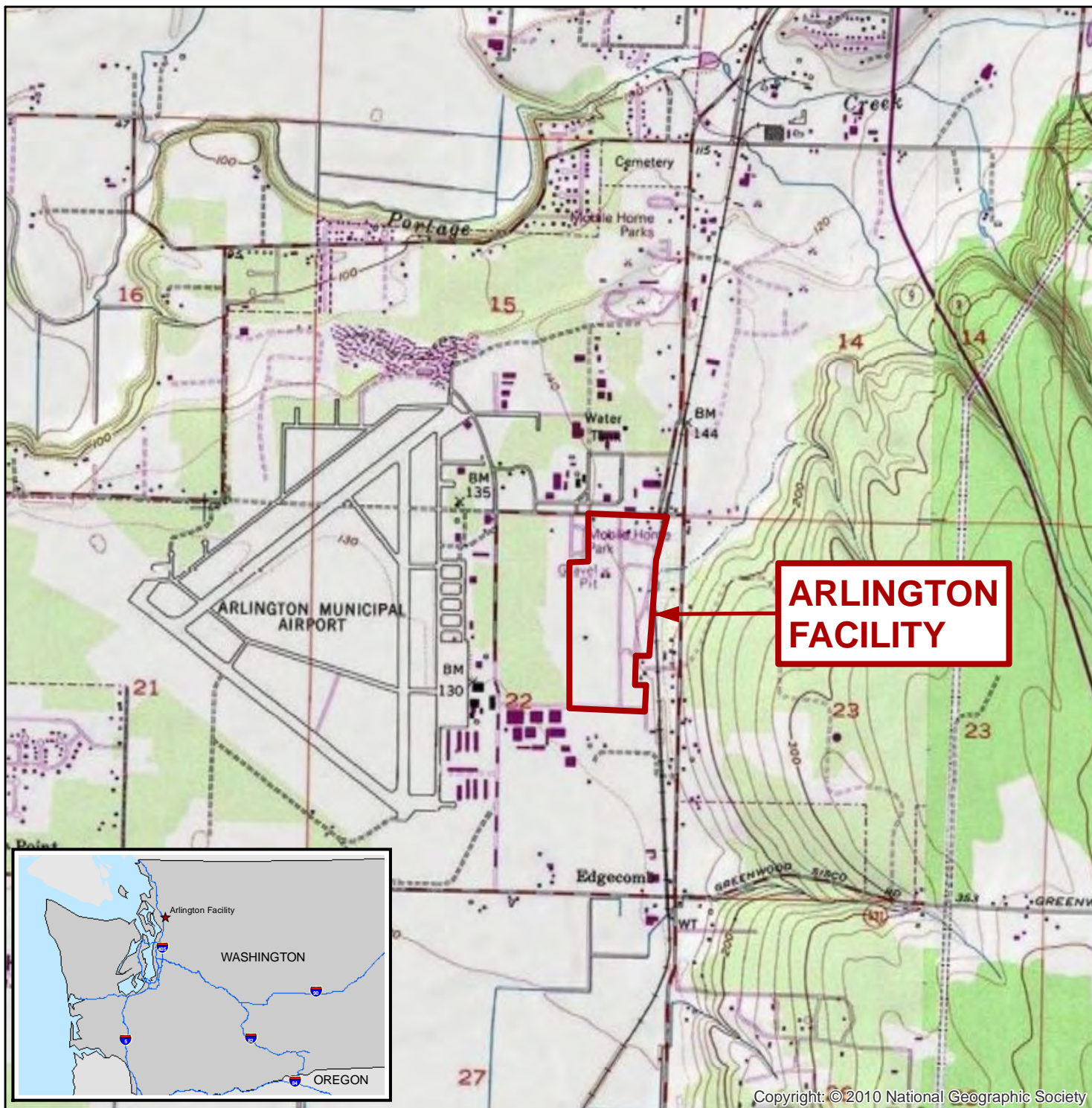
The lowest total score for the combined ranking represents the best overall performance.

2. The Threshold Criteria Ranking comes from Table 11-1.

3. The Balancing Criteria Ranking comes from Table 10-2.

## FIGURES

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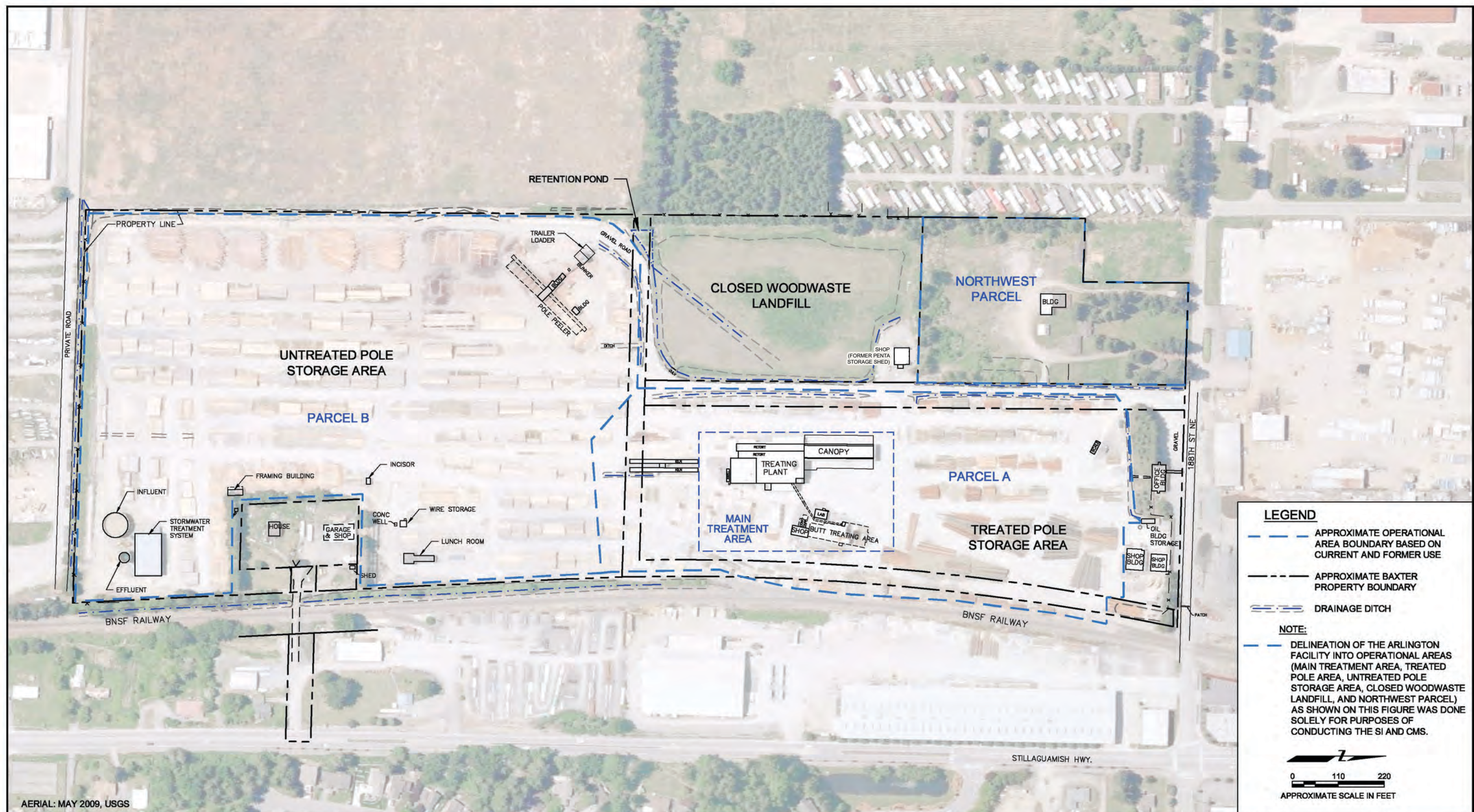
0 1,000 2,000 4,000  
Feet





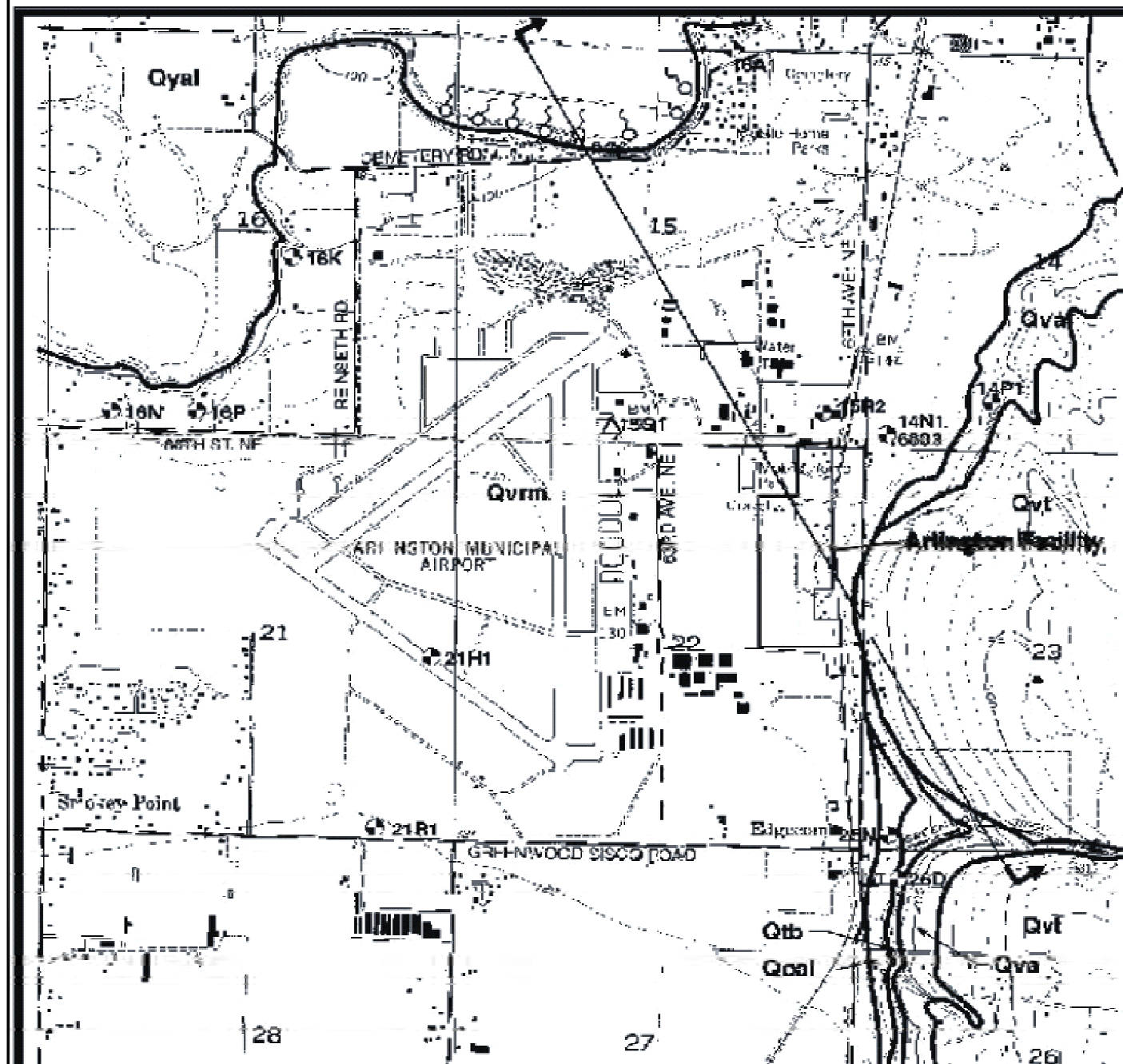
<p><b>AMEC</b> 7376 SW Durham Road Portland, OR, U.S.A. 97224</p>		<p><b>amec</b></p>		<p><b>J.H. BAXTER</b></p>	
<p>TITLE: SITE VICINITY MAP</p>		DWN BY: PM	DATUM: NAD83	DATE: MARCH 2013	
<p>PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA</p>		CHK'D BY: SB	REV. NO.: 1	PROJECT NO.: 161M125611.0001.3	
		PROJECTION: WA SP N. FL.	SCALE: 1 inch = 2,000 feet	FIGURE No.: 1-1	



	CLIENT:		J.H. BAXTER		DWN BY:	APS	PROJECT	FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA		DATE:	MARCH 2013
					CHK'D BY:	SB				PROJECT NO:	3-61M-125611
					DATUM:	-	TITLE	SITE PLAN	REV. NO.:		
					PROJECTION:	-					
					SCALE:	AS SHOWN					
		AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224						FIGURE No.		2-1	

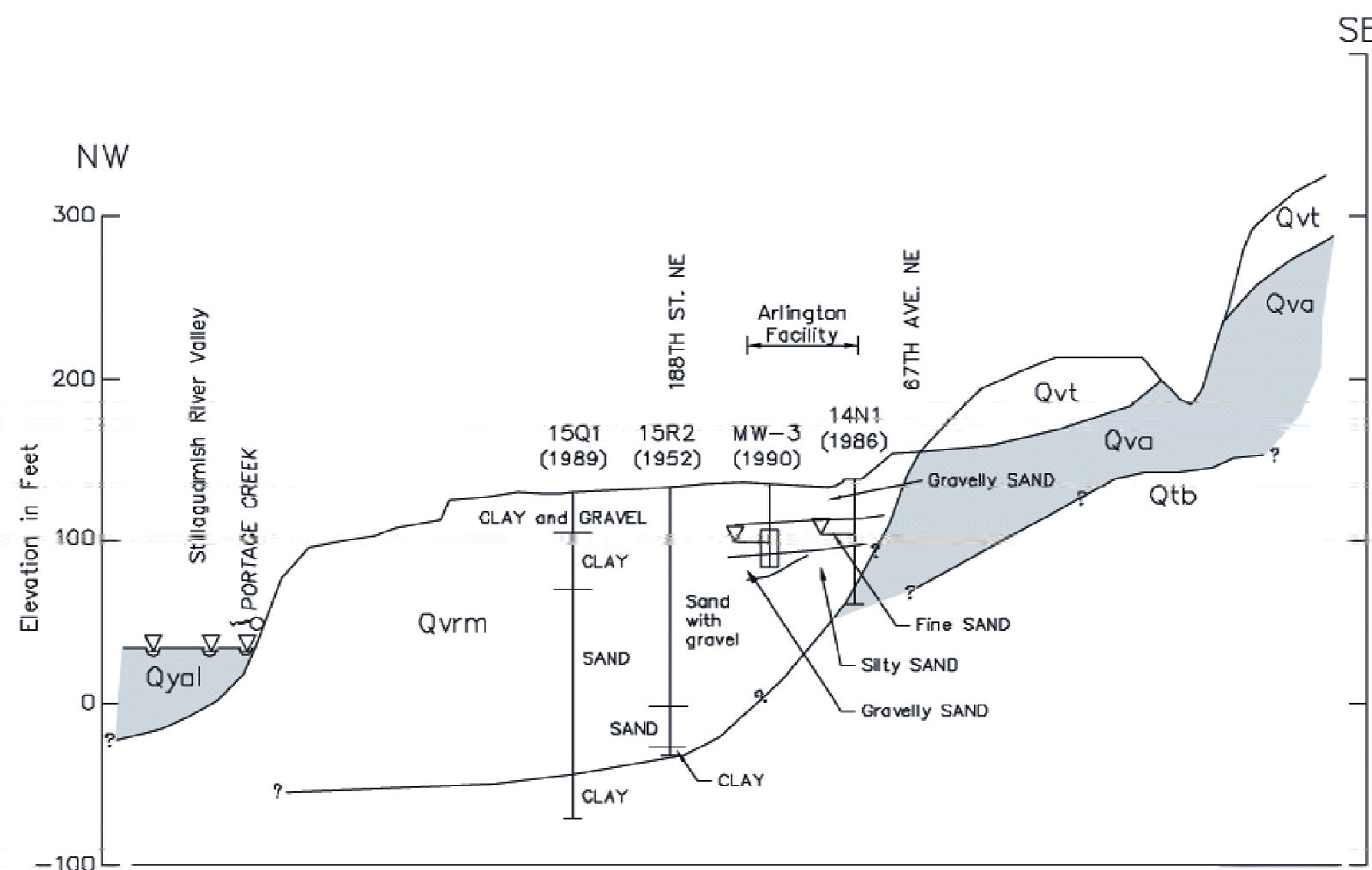


	CLIENT:  J.H. BAXTER		DWN BY: APS	PROJECT FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
			CHK'D BY: SB		PROJECT NO: 3-61M-125611
			DATUM: -		REV. NO.:
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224		PROJECTION: -	TITLE  AREAS OF INVESTIGATION	FIGURE No.  2-2
			SCALE: AS SHOWN		



16A1 Well Log Available from Dept. of Ecology or Newcomb (1952)

15Q1 Ecology Log for Anode Well

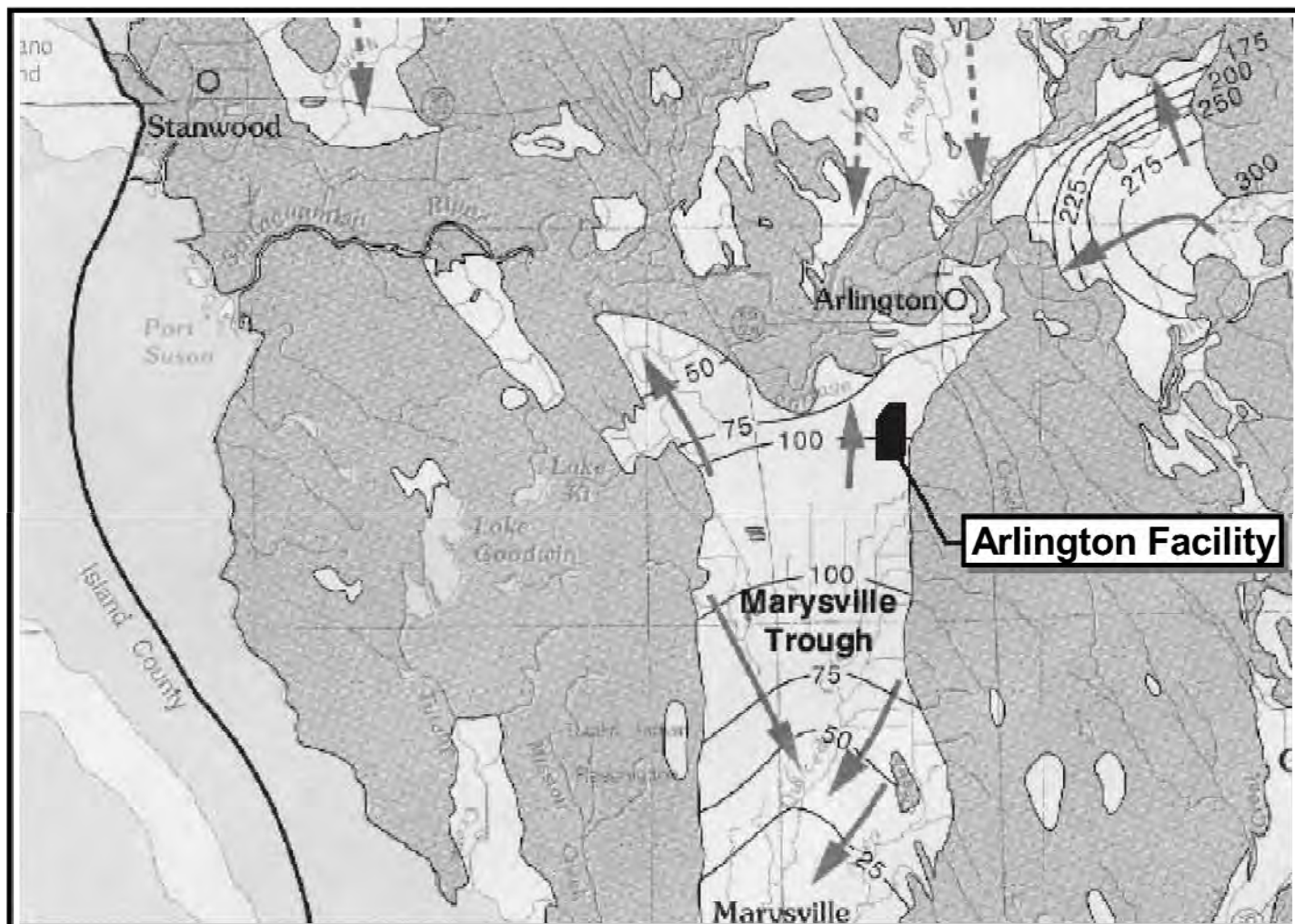


Note: Contacts between soil units are based upon interpolation between borings.

Horizontal Scale in Feet  
0 2000 4000  
Vertical Scale in Feet  
0 100 200  
Vertical Exaggeration x 20

15R2 (1952)	Exploration Number (Date of Log or Data Source)	Geologic Units from Minard (1985)
	Exploration Location	Qyal Younger Alluvium
	Water Level	Qvrm Recessional Outwash - Marysville Member
	Screened Interval (When available)	Qvt Till
	Seep	Qva Advance Outwash
		Qtb Transitional Beds Silt

	CLIENT: J.H. BAXTER		DWN BY: PM	PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
	AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224		CHK'D BY: SB		PROJECT NO: 361M 125611.0001.3
		TITLE: REGIONAL GEOLOGIC MAP AND CROSS SECTION		REV. NO.: A	
		SCALE: AS SHOWN		FIGURE No. 2-3	



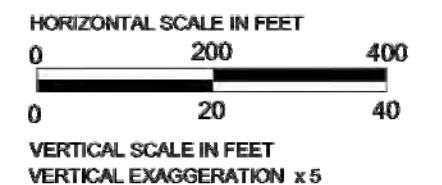
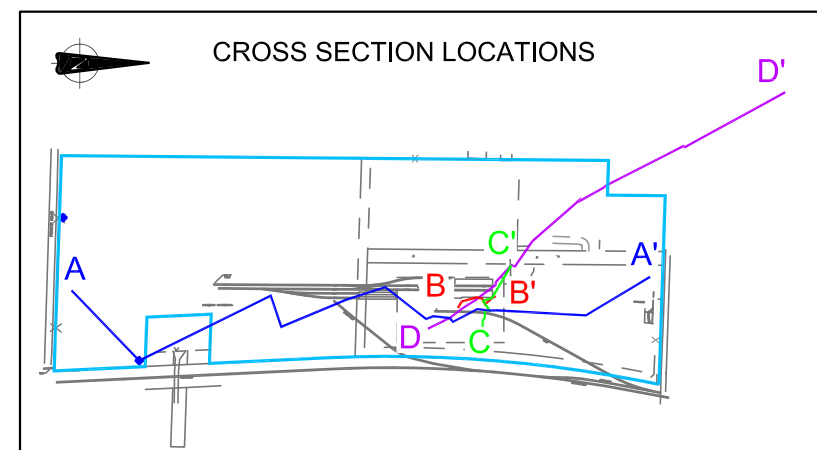
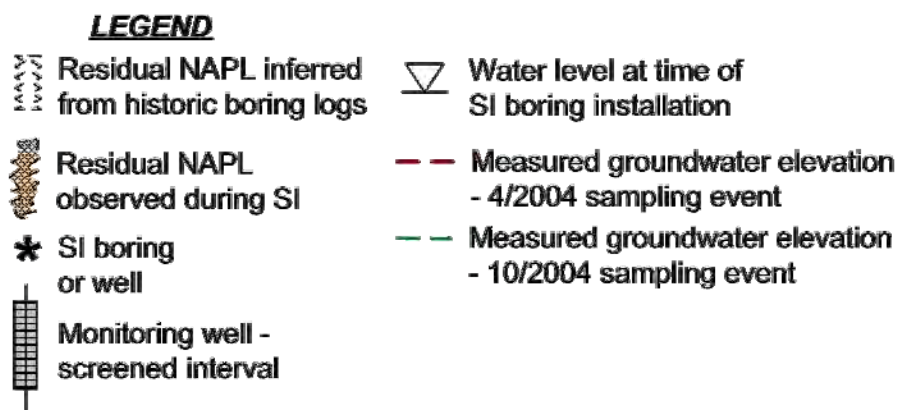
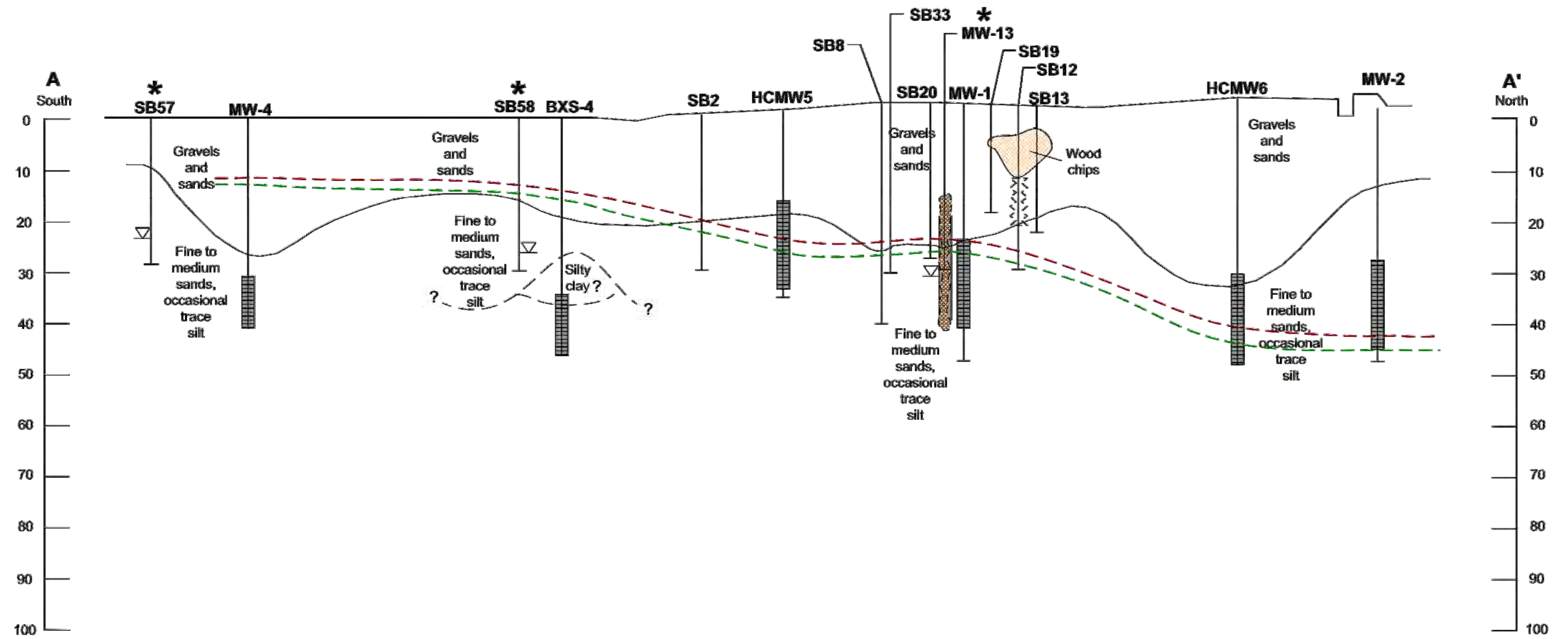
**Note:**  
Map created by base map by B.E. Thomas, J.M. Wilkinson,  
and S.S. Embrey, entitled "Plate 6. Areal Recharge From  
Precipitation and Potentiometric Surfaces of Principal  
Aquifers, Western Snohomish County, Washington,"  
dated 1997




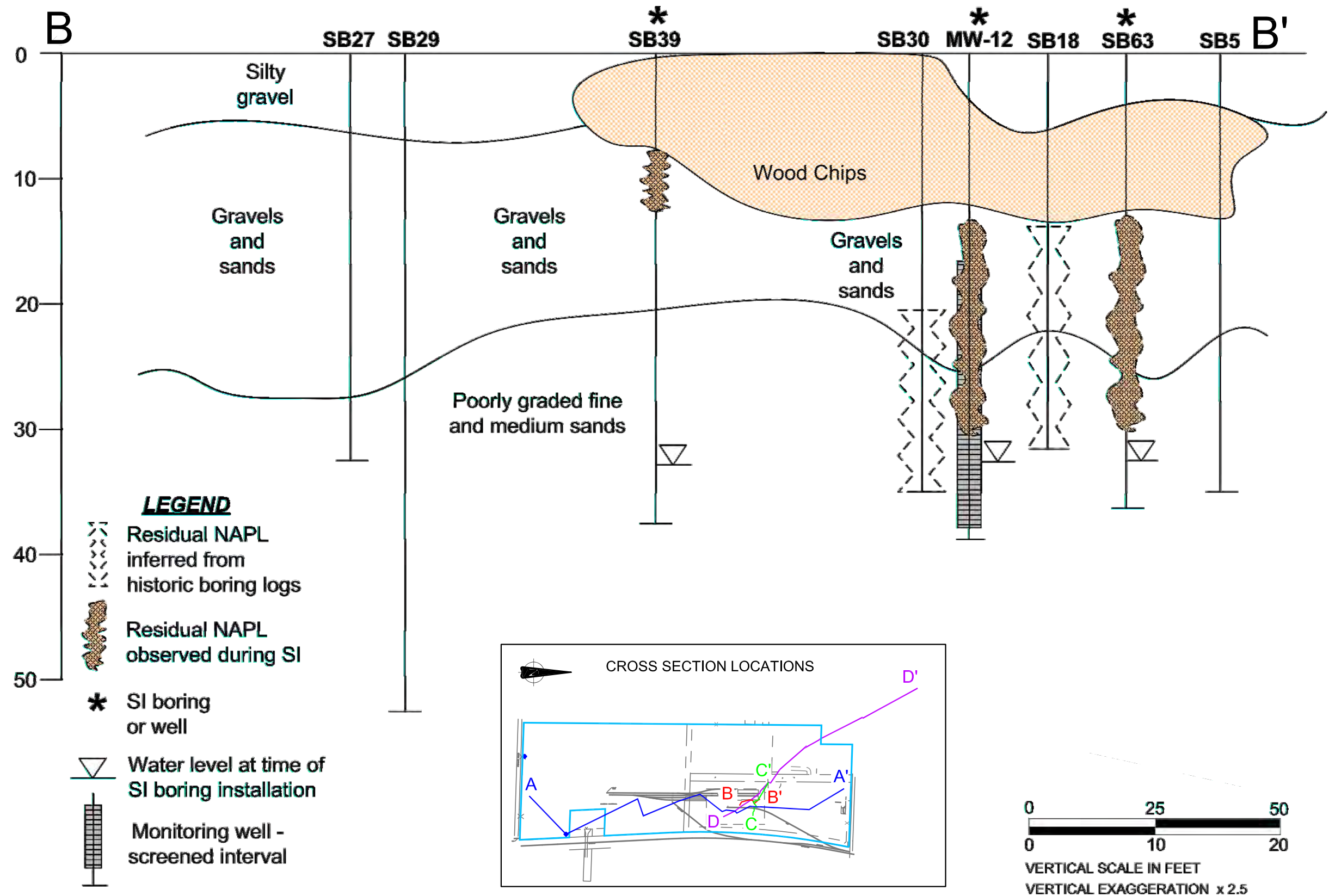
### LEGEND

- 50 Groundwater Elevation  
Groundwater Elevation Contour  
Inferred Groundwater Flow Direction

<p align="center"><b>AMEC</b></p> <p align="center">7376 S.W. Durham Road Portland OR, U.S.A. 97224</p>				<p align="center">CLIENT</p> <p align="center"><b>J.H. BAXTER</b></p>	
<p>TITLE: REGIONAL GROUNDWATER FLOW DIRECTION</p>			<p>DWN BY: PM</p>	<p>DATUM: -</p>	<p>DATE: MARCH 2013</p>
<p>PROJECT: FORMER J.H. BAXTER AND CO. WOOD TREATMENT FACILITY ARLINGTON, WA</p>			<p>CHK'D BY: SB</p>	<p>REV. NO.: A</p>	<p>PROJECT NO: 361M 125611.0001.3</p>
			<p>PROJECTION: -</p>	<p>SCALE: -</p>	<p>FIGURE No. 2-4</p>



CLIENT:  J.H. BAXTER		DWN BY: PM		PROJECT  FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013	
		CHK'D BY: SB			PROJECT NO: 361M 125611.0001.3	
		DATUM: -			REV. NO.: A	
<div>AMEC</div> <div>7376 S.W. Durham Road Portland, OR. U.S.A. 97224</div>		<div>amec</div>		TITLE		FIGURE No. 2-5
				CROSS SECTION A-A'		



CLIENT:

J.H. BAXTER



AMEC  
7376 S.W. Durham Road  
Portland, OR. U.S.A. 97224



DWN BY:

PM

CHK'D BY:

SB

DATUM:

PROJECTION:

SCALE:

AS SHOWN

PROJECT

FORMER J.H. BAXTER AND CO.  
WOOD TREATING FACILITY  
ARLINGTON, WA

TITLE

CROSS SECTION B-B'

DATE:

MARCH 2013

PROJECT NO:

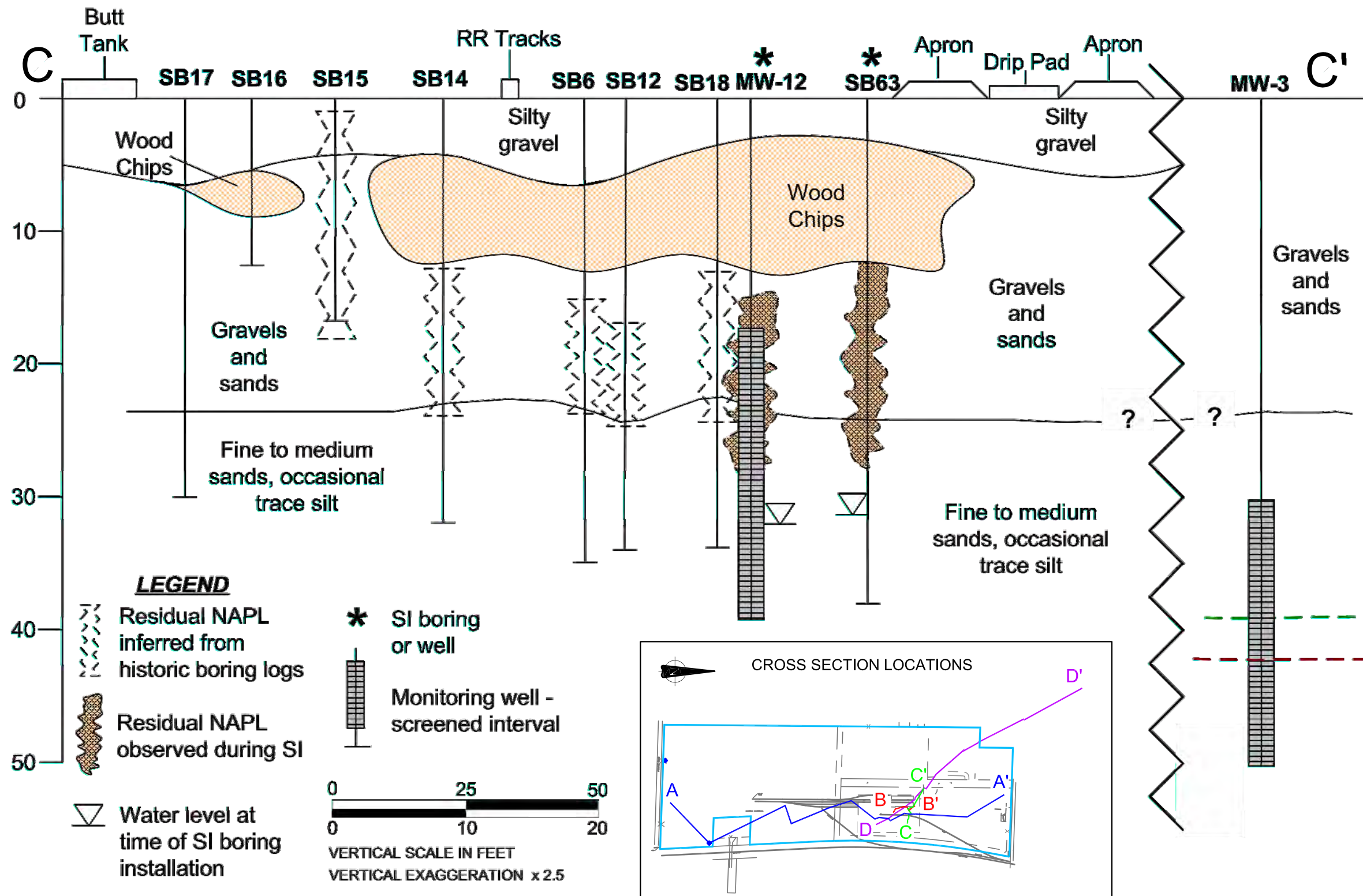
361M 125611.0001.3

REV. NO.:

A

FIGURE No.

2-6

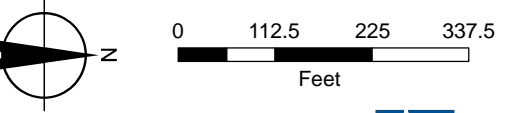
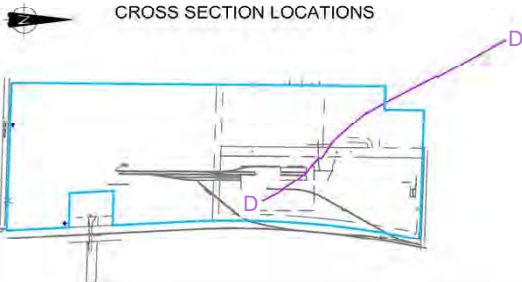


		CLIENT:  J.H. BAXTER		DWN BY:	PM	PROJECT  FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE:	MARCH 2013	
				CHK'D BY:	SB		PROJECT NO:	361M 125611.0001.3	
				DATUM:	-		REV. NO.:	A	
		AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224			PROJECTION:	-	TITLE  CROSS SECTION C-C'	FIGURE No.	2-7
					SCALE:	AS SHOWN			

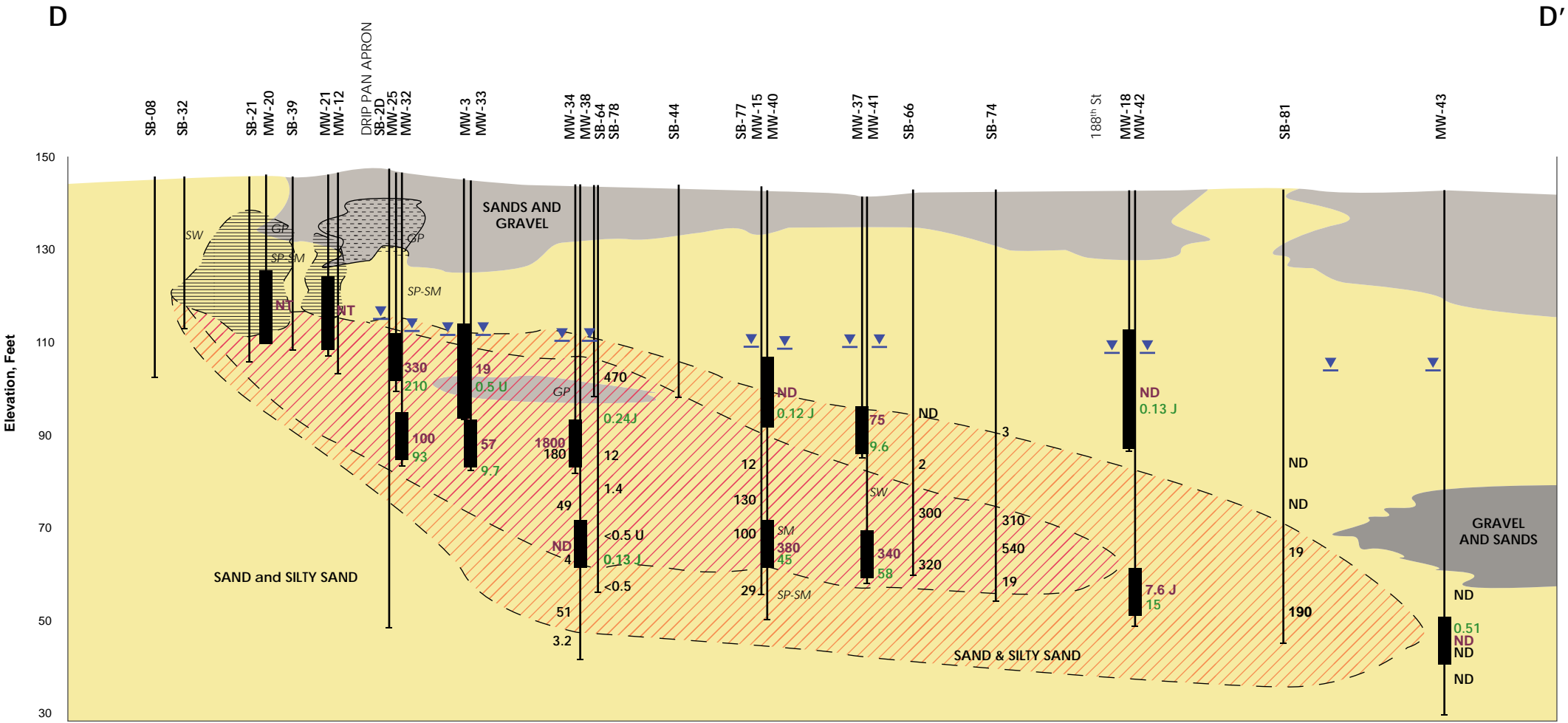
**FIGURE 2-8**  
**Cross Section D-D'**  
 Former J.H. Baxter  
 Wood Treating Facility  
 Arlington, Washington

- LEGEND**
- 340 Pentachlorophenol (PCP) Concentration in ug/L, Sept. 2016
  - 340 Pentachlorophenol (PCP) Concentration in ug/L, Feb. 2015
  - 340 Pentachlorophenol (PCP) Concentration in Groundwater grab samples from the borehole, ug/L
  - Approximate Water Level in February 2015
  - Monitoring Well Cluster, Identifier, and Screen Interval
  - Sands and Gravel
  - Gravel and Sands
  - Sand and Silty Sand
  - Residual Light Non-Aqueous Phase Liquid (LNAPL)
  - Wood Debris
  - Approximate Extent of PCP in Groundwater >5 ug/L (using max concentrations since 2008)
  - Approximate Extent of PCP in Groundwater >300 ug/L (using max concentrations since 2008)

- NOTES:**
- GP: Poorly Graded Gravel
  - ND: Not Detected
  - NT: Not Tested
  - SM: Silty Sand
  - SP-SM: Poorly Graded Sand with Silt
  - SW: Well Graded Sand



**MAP NOTES:**  
 Date: December 1, 2016  
 Data Sources: Amec, Figure 39, December 2014





**FIGURE 2-9**  
**Pentachlorophenol Isopleth Map:**  
**First Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

- Shallow Monitoring Well and Pentachlorophenol (PCP) Concentration (□g/L) February 2016
- Intermediate Monitoring Well and Pentachlorophenol (PCP) Concentration (□g/L) February 2016

Pentachlorophenol Concentrations (□g/L)

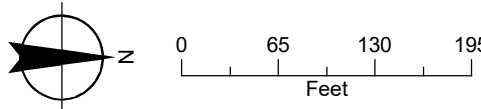
- >100
- >50 - 100
- >10 - 50
- >1 - 10

All Other Features

- Extraction Well
- Infiltration Gallery Piping
- Infiltration Trench
- Groundwater Elevation Contours (dashed where inferred)

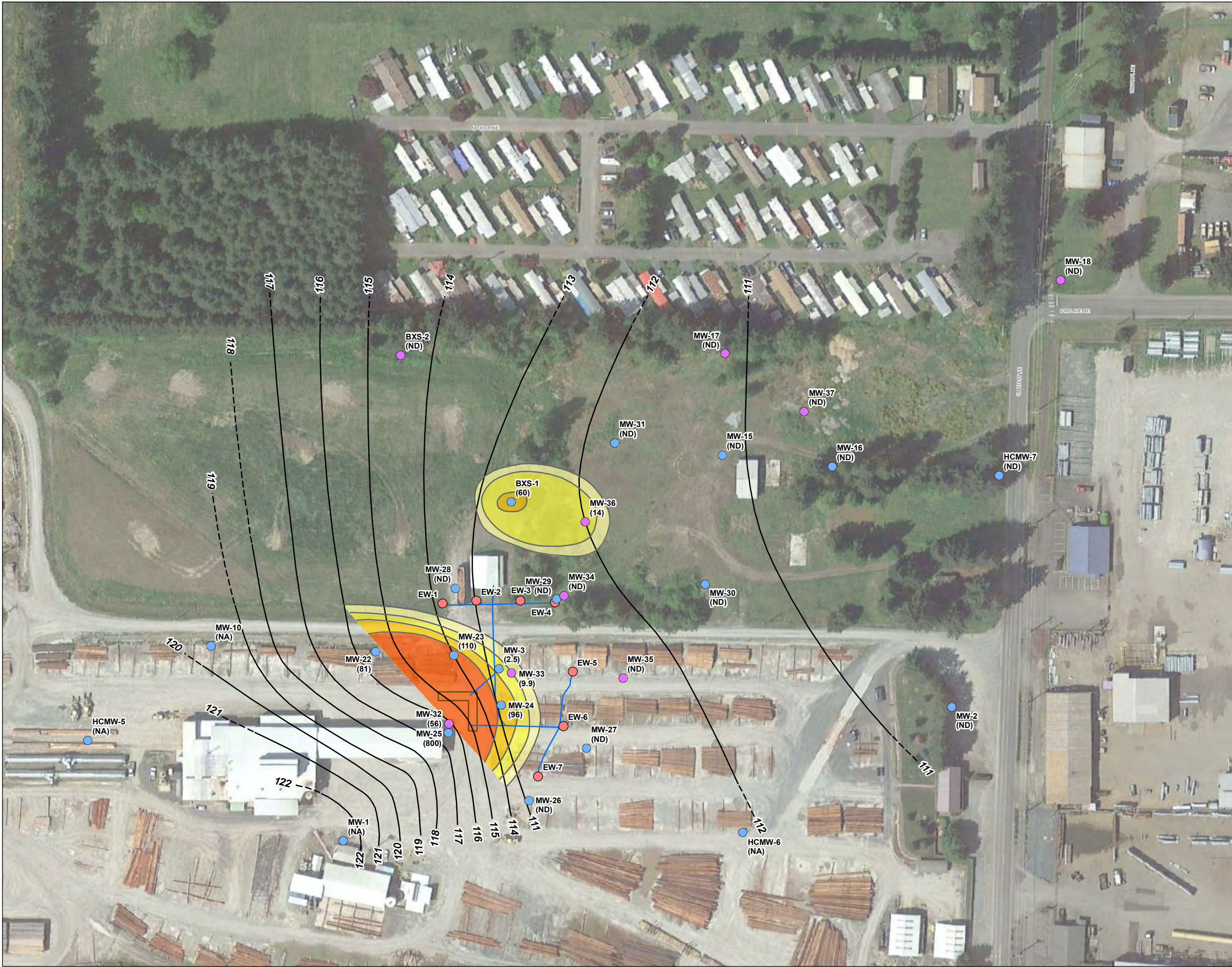
**NOTES:**

- Results in □g/L.
- All elevations exist in the North American Vertical Datum of 1988.
- Abbreviations:  
NA Not Analyzed  
ND Not Detected



Date: February 10, 2017  
Data Sources: AMEC, ESRI, Air photo taken on May 2, 2015 by Google Earth





**FIGURE 2-10**  
**Pentachlorophenol Isopleth Map:**  
**Second Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

- Shallow Monitoring Well and Pentachlorophenol (PCP) Concentration (□g/L) June 2016
- Intermediate Monitoring Well and Pentachlorophenol (PCP) Concentration (□g/L) June 2016

Pentachlorophenol Concentrations (□g/L)

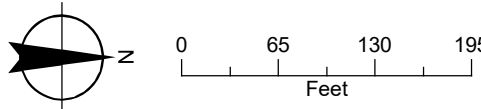
- >100
- >50 - 100
- >10 - 50
- >1 - 10

All Other Features

- Extraction Well
- Infiltration Gallery Piping
- Infiltration Trench
- Groundwater Elevation Contours (dashed where inferred)

**NOTES:**

- Results in □g/L.
- All elevations exist in the North American Vertical Datum of 1988.
- Abbreviations:  
NA Not Analyzed  
ND Not Detected



Date: February 10, 2017  
Data Sources: AMEC, ESRI, Air photo taken on May 2, 2015 by Google Earth





**FIGURE 2-11**  
**Pentachlorophenol Isopleth**  
**Map: Third Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

● Shallow Monitoring Well and Pentachlorophenol (PCP) Concentration (µg/L) September 2016

● Intermediate Monitoring Well and Pentachlorophenol (PCP) Concentration (µg/L) September 2016

**PCP Concentrations (µg/L)**

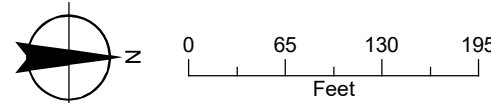
- >500
- 300-500
- 100-300
- 50-100
- 10-50
- 1-10

**All Other Features**

- Extraction Well
- Infiltration Gallery Piping
- Infiltration Trench
- Groundwater Elevation Contours (dashed where inferred)

**NOTES:**

1. Results in µg/L.
2. All elevations exist in the North American Vertical Datum of 1988.
3. Abbreviations:  
NA Not Analyzed  
ND Not Detected



Date: February 10, 2017  
Data Sources: AMEC, ESRI, Air photo taken on May 2, 2015 by Google Earth





**FIGURE 2-12**  
**Pentachlorophenol Isopleth**  
**Map: Fourth Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

● Shallow Monitoring Well and Pentachlorophenol (PCP) Concentration (µg/L) November 2016

● Intermediate Monitoring Well and Pentachlorophenol (PCP) Concentration (µg/L) November 2016

**PCP Concentrations (µg/L)**

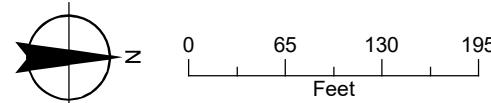
- >500
- 300-500
- 100-300
- 50-100
- 10-50
- 1-10

**All Other Features**

- Extraction Well
- Infiltration Gallery Piping
- Infiltration Trench
- Groundwater Elevation Contours (dashed where inferred)

**NOTES:**

1. Results in µg/L.
2. All elevations exist in the North American Vertical Datum of 1988.
3. Abbreviations:  
NA Not Analyzed  
ND Not Detected



Date: February 10, 2017  
Data Sources: AMEC, ESRI, Air photo taken on May 2, 2015 by Google Earth





**FIGURE 2-13**  
**Pentachlorophenol Isopleth Map,**  
**Deep Zone: First Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

● Deep Monitoring Well and Pentachlorophenol (PCP) Concentration (µg/L) February 2016

**Pentachlorophenol Concentrations (µg/L)**

- >300
- >100 - 300
- >50 - 100
- >10 - 50
- >1 - 10

**All Other Features**

- Extraction Well
- Infiltration Gallery Piping
- ▭ Infiltration Trench

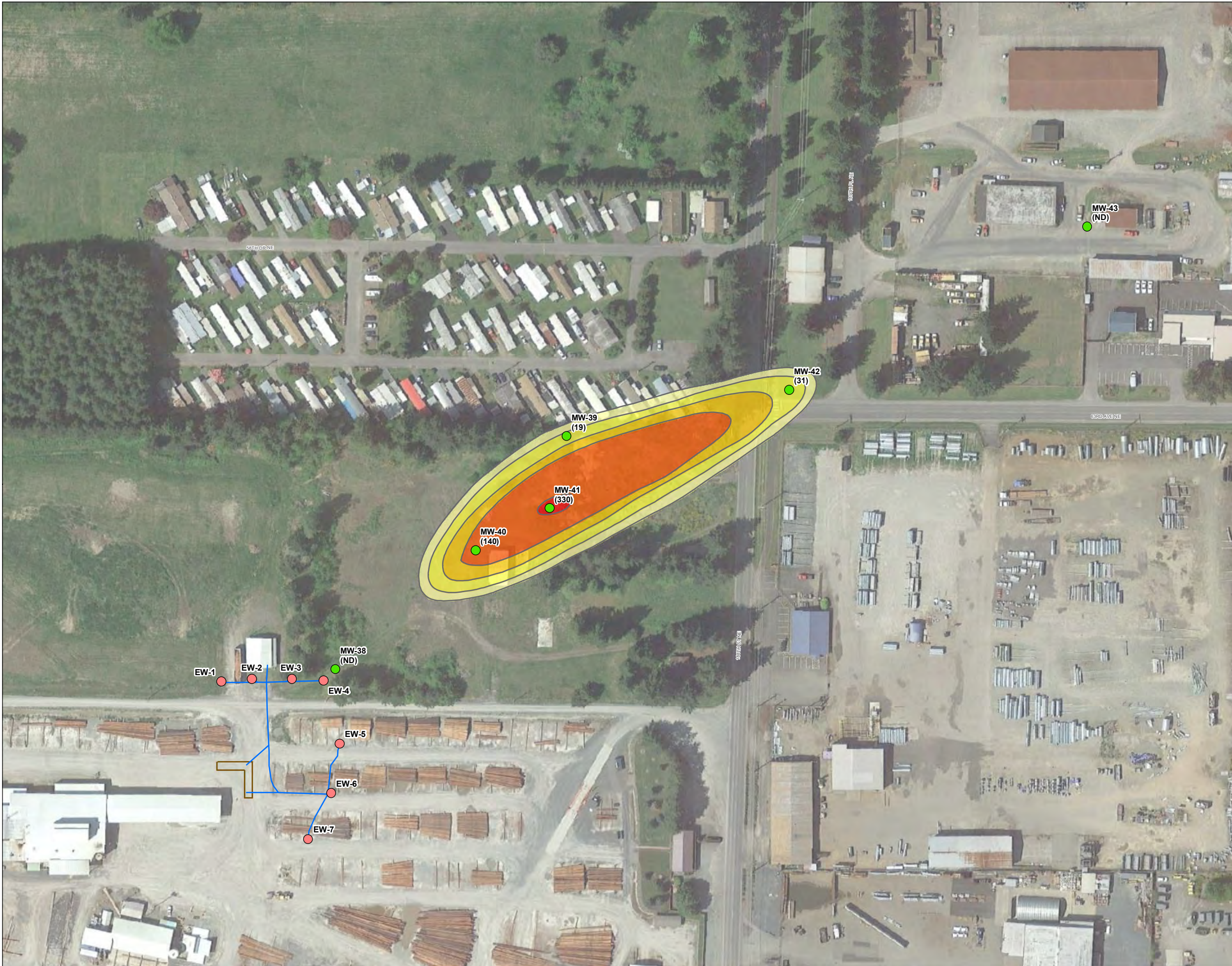
**NOTES:**

- Results in µg/L.
- All elevations exist in the North American Vertical Datum of 1988.
- Abbreviations:  
NA Not Analyzed  
ND Not Detected



Date: February 10, 2017  
Data Sources: AMEC, ESRI, Air photo taken on  
May 2, 2015 by Google Earth





**FIGURE 2-14**  
**Pentachlorophenol Isopleth Map,**  
**Deep Zone: Second Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

● Deep Monitoring Well and Pentachlorophenol (PCP) Concentration (µg/L) June 2016

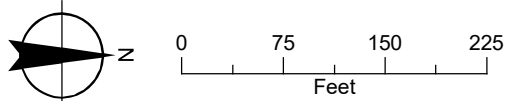
**Pentachlorophenol Concentrations (µg/L)**

- >300
- >100 - 300
- >50 - 100
- >10 - 50
- >1 - 10

**All Other Features**

- Extraction Well
- Infiltration Gallery Piping
- Infiltration Trench

- NOTES:**
1. Results in µg/L.
  2. All elevations exist in the North American Vertical Datum of 1988.
  3. Abbreviations:  
NA Not Analyzed  
ND Not Detected





**FIGURE 2-15**  
**Pentachlorophenol Isopleth Map,**  
**Deep Zone: Third Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

● Deep Monitoring Well and Pentachlorophenol (PCP) Concentration (µg/L) September 2016

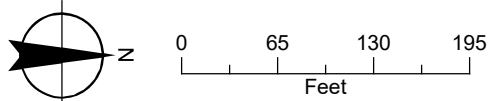
**PCP Concentrations (µg/L)**

- >500
- 300-500
- 100-300
- 50-100
- 10-50
- 1-10

**All Other Features**

- Extraction Well
- Infiltration Gallery Piping
- ▭ Infiltration Trench

- NOTES:**
- Results in µg/L.
  - All elevations exist in the North American Vertical Datum of 1988.
  - Abbreviations:  
ND Not Detected  
J Estimated



Date: February 10, 2017  
Data Sources: AMEC, ESRI, Air photo taken on  
May 2, 2015 by Google Earth





**FIGURE 2-16**  
**Pentachlorophenol Isopleth Map,**  
**Deep Zone: Fourth Quarter 2016**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

● Deep Monitoring Well and Pentachlorophenol (PCP) Concentration (ug/L) November 2016

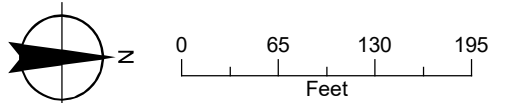
**PCP Concentrations (ug/L)**

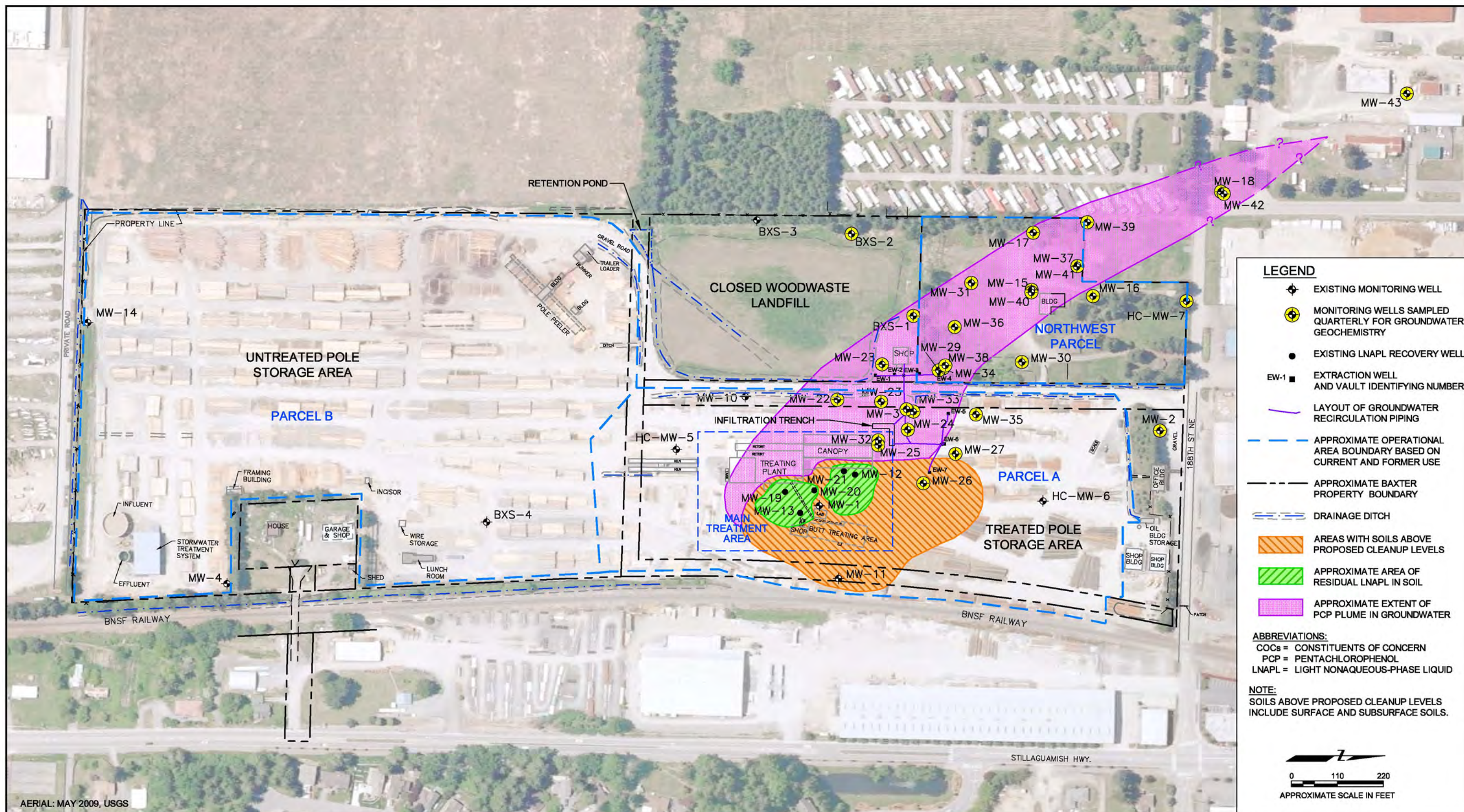
>500
300-500
100-300
50-100
10-50
1-10

**All Other Features**

- Extraction Well
- Infiltration Gallery Piping
- ▭ Infiltration Trench
- ~ Groundwater Elevation Contours (dashed where inferred)

- NOTES:**
1. Results in ug/L.
  2. All elevations exist in the North American Vertical Datum of 1988.
  3. Abbreviations:  
NA Not Analyzed  
ND Not Detected





AERIAL: MAY 2009, USGS



CLIENT:

J.H. BAXTER

**AMEC**  
 7376 S.W. Durham Road  
 Portland, OR. U.S.A. 97224



DWN BY:

APS

CHKD BY:

SB

DATUM:

-

PROJECTION:

-

SCALE:

AS SHOWN

PROJECT

**FORMER J.H. BAXTER AND CO.  
 WOOD TREATING FACILITY  
 ARLINGTON, WA**

TITLE

**AREAS OF CONCERN**

DATE:

MARCH 2013

PROJECT NO:

3-61M-125611

REV. NO.:

A

FIGURE No.

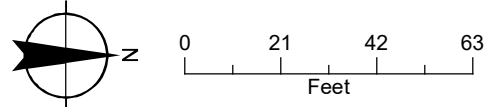
4-1



**FIGURE 4-2**  
**Residual NAPL Thickness**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

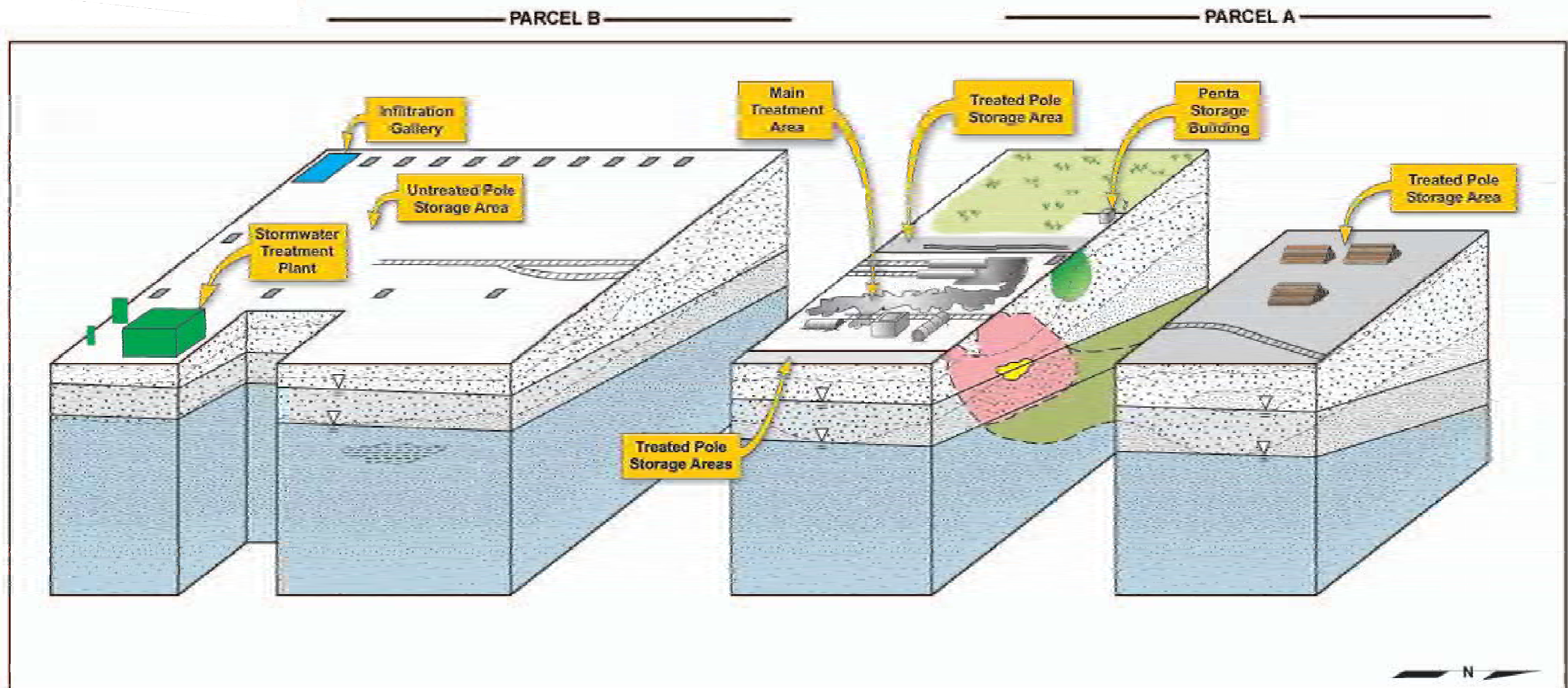
- LEGEND**
- Monitoring Well, NAPL Observed
  - Monitoring Well, NAPL not Observed
  - Soil Boring, NAPL Observed
  - Soil Boring, NAPL not Observed
  - Boring Advanced Below Depth of Visual or Olfactory Signs of Contamination
  - Estimated NAPL Extent
- All Other Features**
- Infiltration Gallery Piping
  - Infiltration Trench
  - Historical Process Units

**NOTE:**  
NAPL: Nonaqueous Phase Liquid  
Soil Boring Location values are residual  
NAPL thickness in feet.



Date: February 21, 2017  
Data Sources: AMEC, ESRI, Air photo taken on  
May 2, 2015 by Google Earth





### Legend:



#### Soil Types



**Note:** Surface features shown larger than actual size.

Horizontal Scale in Feet



Vertical Scale in Feet

Vertical Exaggeration x15

CLIENT:

J.H. BAXTER



AMEC

7376 S.W. Durham Road  
Portland, OR. U.S.A. 97224



DWN BY:

PM

CHK'D BY:

SB

DATUM:

-

PROJECTION:

-

SCALE:

AS SHOWN

PROJECT

FORMER J.H. BAXTER AND CO.  
WOOD TREATING FACILITY  
ARLINGTON, WA

TITLE

CONCEPTUAL SITE MODEL

DATE:

MARCH 2013

PROJECT NO:

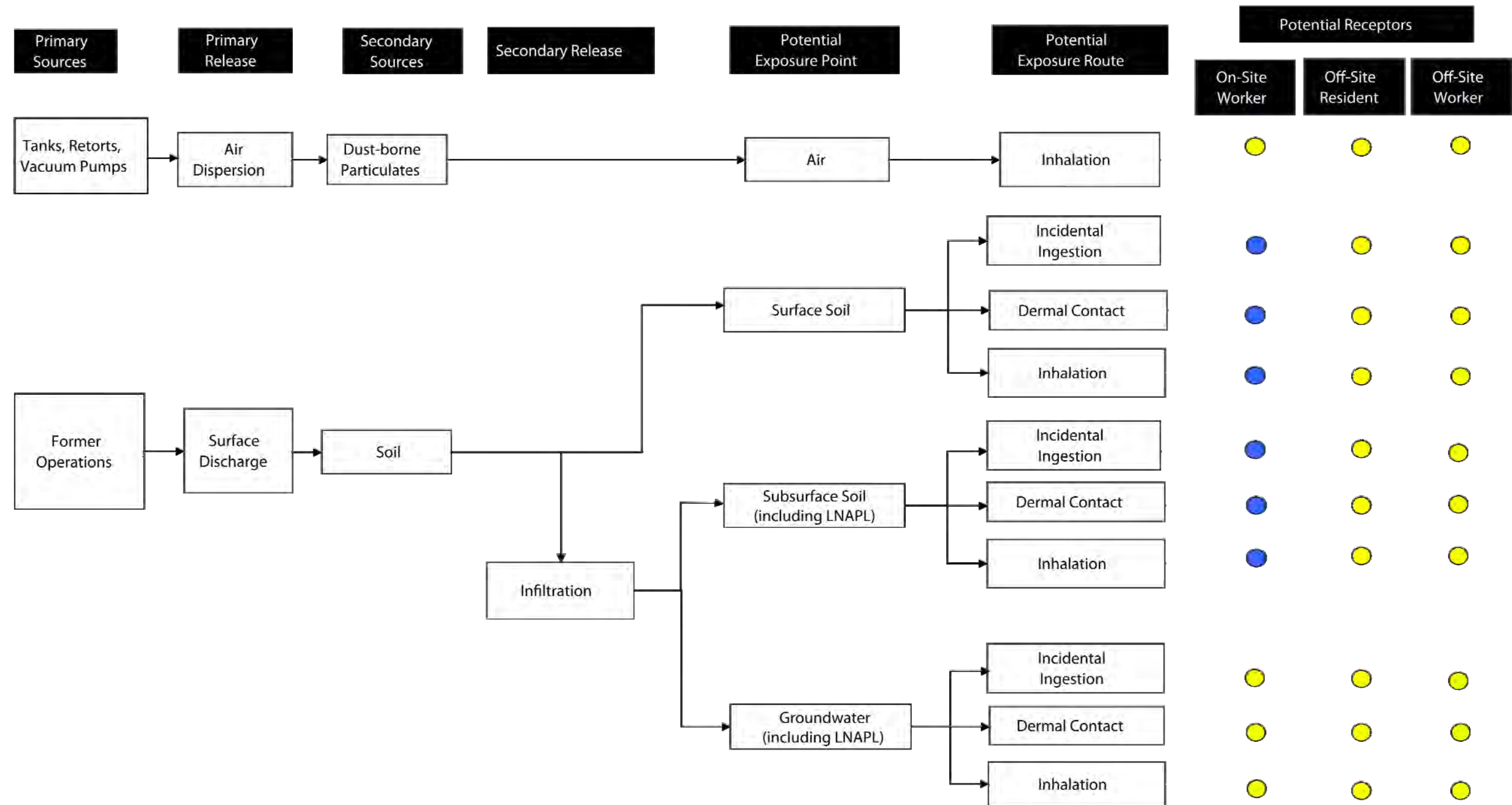
361M 125611.0001.3

REV. NO.:

A

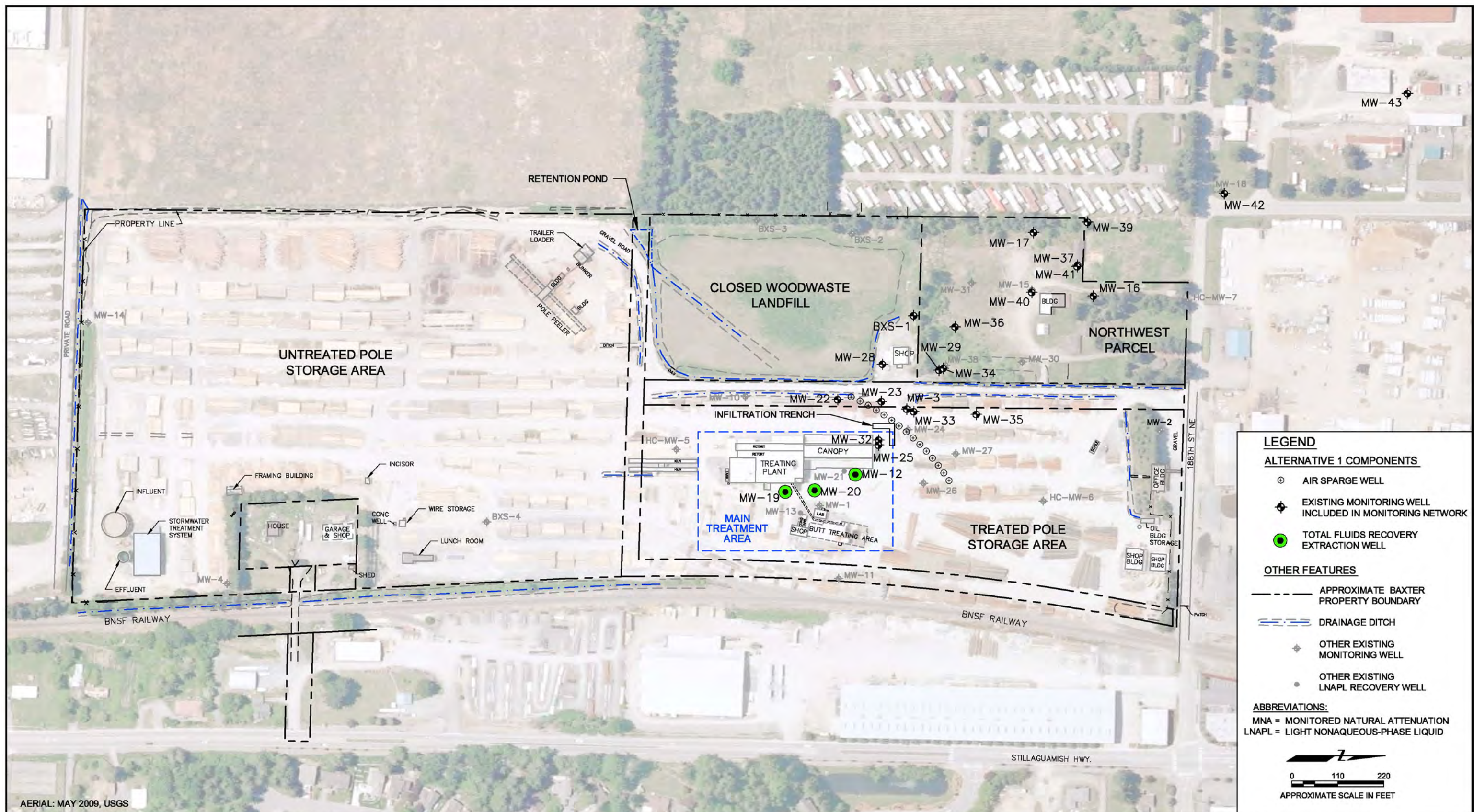
FIGURE No.

5-1



● Potentially incomplete exposure pathway  
 ● Potentially complete exposure pathway

		CLIENT:  J.H. BAXTER		DWN BY: PM	PROJECT  FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA	DATE: MARCH 2013
		AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224		CHK'D BY: SB		PROJECT NO: 361M 125611.0001.3
				DATUM: -	TITLE  CONCEPTUAL SITE MODEL OF POTENTIAL EXPOSURE PATHWAYS	REV. NO.: A
				PROJECTION: -		FIGURE No. 5-2
				SCALE: AS SHOWN		



AERIAL: MAY 2009, USGS

CLIENT:

J.H. BAXTER



AMEC

7376 S.W. Durham Road  
Portland, OR. U.S.A. 97224



DWN BY:

APS

CHKD BY:

SB

DATUM:

-

PROJECTION:

-

SCALE:

AS SHOWN

PROJECT

FORMER J.H. BAXTER AND CO.  
WOOD TREATING FACILITY  
ARLINGTON, WA

TITLE

ALTERNATIVE 1  
TOTAL FLUIDS RECOVERY,  
AIR SPARGING, AND MNA

DATE:

MARCH 2013

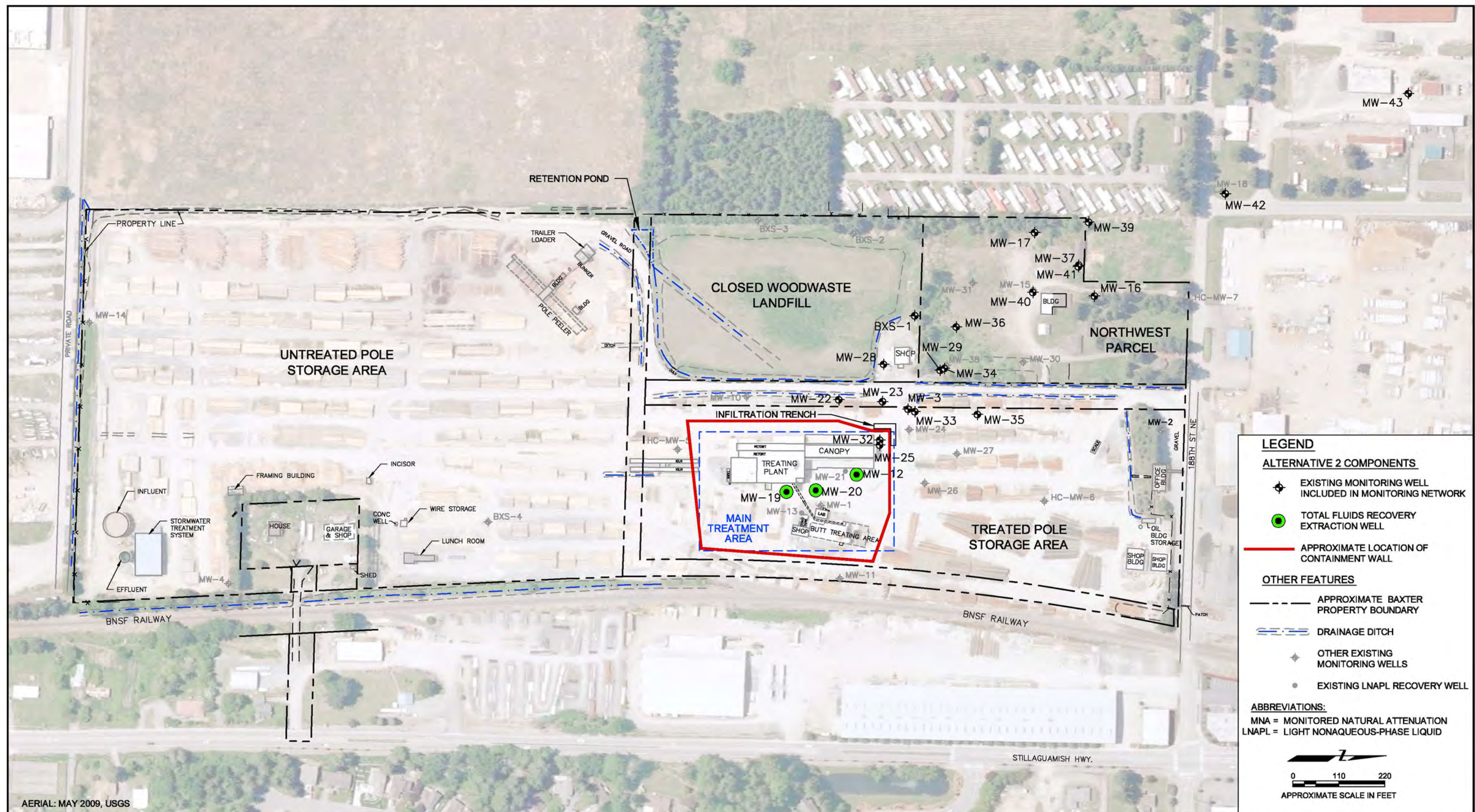
PROJECT NO:

3-61M-125611

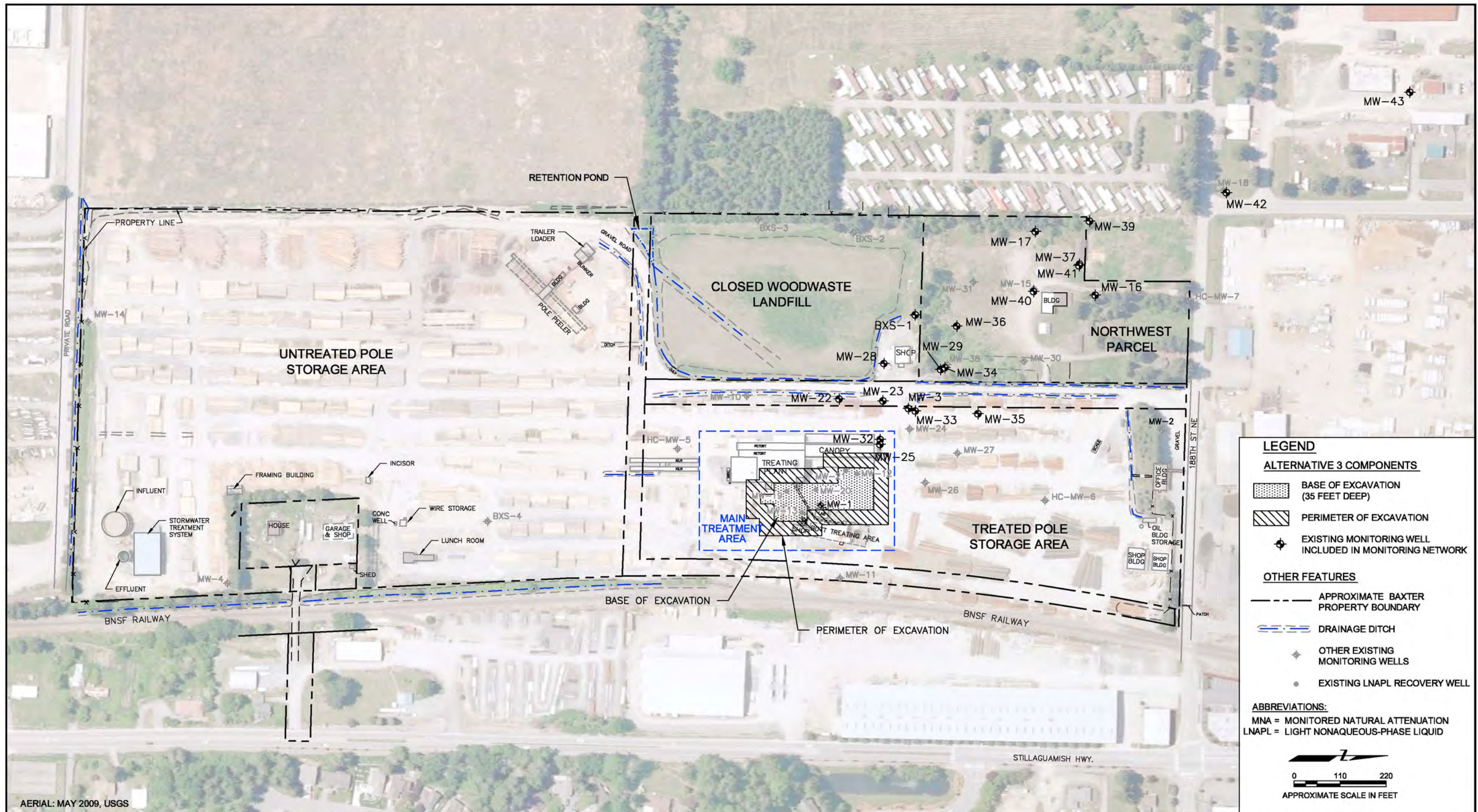
REV. NO.:

FIGURE No.

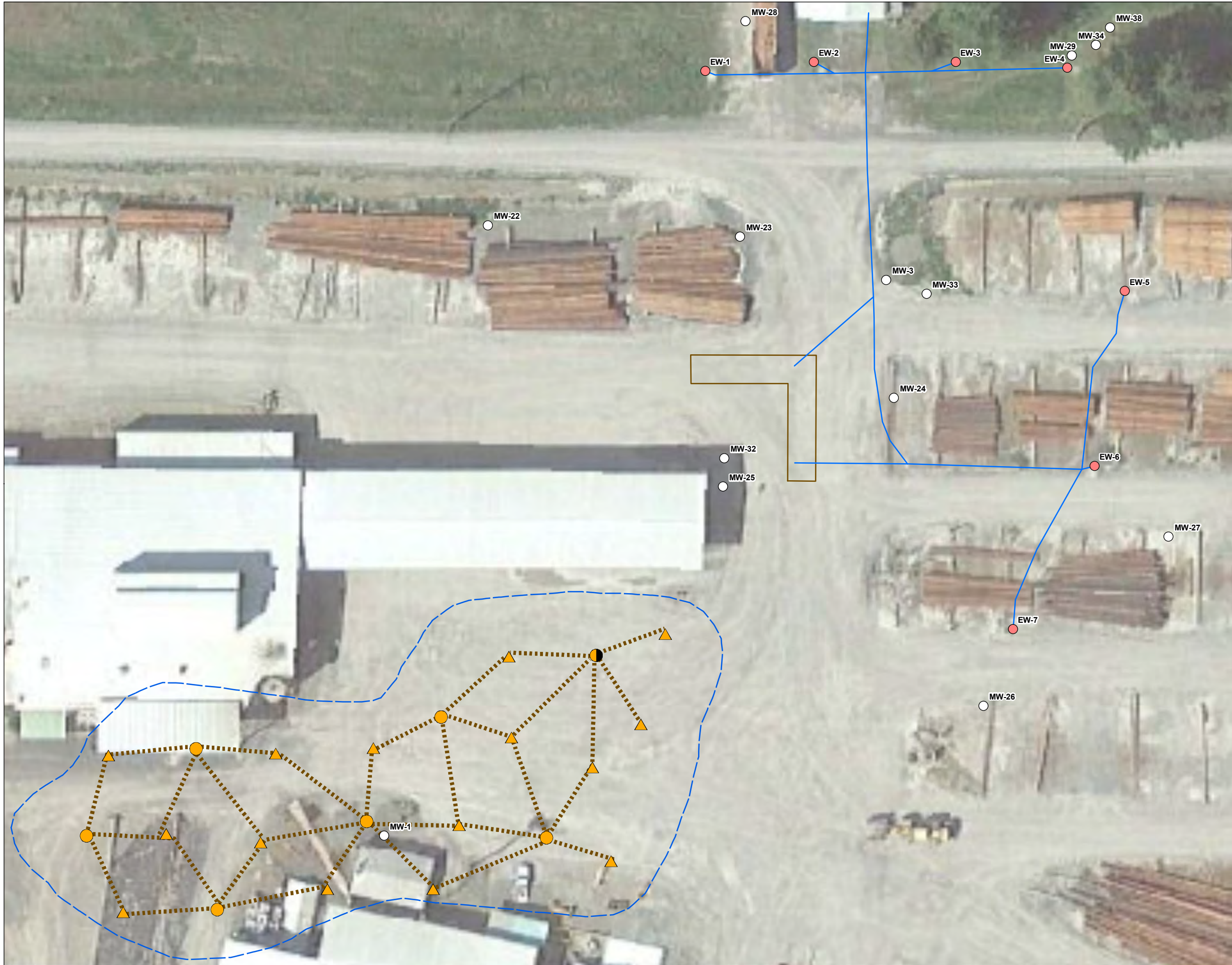
9-1



	<b>CLIENT:</b> J.H. BAXTER	<b>DWN BY:</b> APS <b>CHKD BY:</b> SB <b>DATUM:</b> - <b>PROJECTION:</b> - <b>SCALE:</b> AS SHOWN	<b>PROJECT</b> FORMER J.H. BAXTER AND CO. WOOD TREATING FACILITY ARLINGTON, WA  <b>TITLE</b> ALTERNATIVE 2 PHYSICAL/HYDRAULIC CONTAINMENT AND MNA	<b>DATE:</b> MARCH 2013
				<b>PROJECT NO:</b> 3-61M-125611 <b>REV. NO.:</b> <b>FIGURE No.</b> 9-2



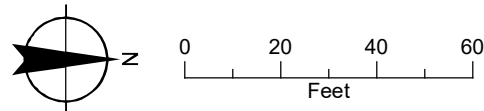
	<b>CLIENT:</b>  J.H. BAXTER  AMEC 7376 S.W. Durham Road Portland, OR. U.S.A. 97224	<b>DWN BY:</b> APS <b>CHKD BY:</b> SB <b>DATUM:</b> - <b>PROJECTION:</b> - <b>SCALE:</b> AS SHOWN	<b>PROJECT</b> <b>FORMER J.H. BAXTER AND CO.</b> <b>WOOD TREATING FACILITY</b> <b>ARLINGTON, WA</b>  <b>TITLE</b> <b>ALTERNATIVE 3</b> <b>EXCAVATION, OFF-SITE DISPOSAL, AND MNA</b>	<b>DATE:</b> MARCH 2013 <b>PROJECT NO:</b> 3-61M-125611 <b>REV. NO.:</b> <b>FIGURE No.</b> 9-3



**FIGURE 9-4**  
**Alternative 4**  
**Enhanced Biodegradation**  
**Recirculation System**  
Former J.H. Baxter  
Wood Treating Facility  
Arlington, Washington

**LEGEND**

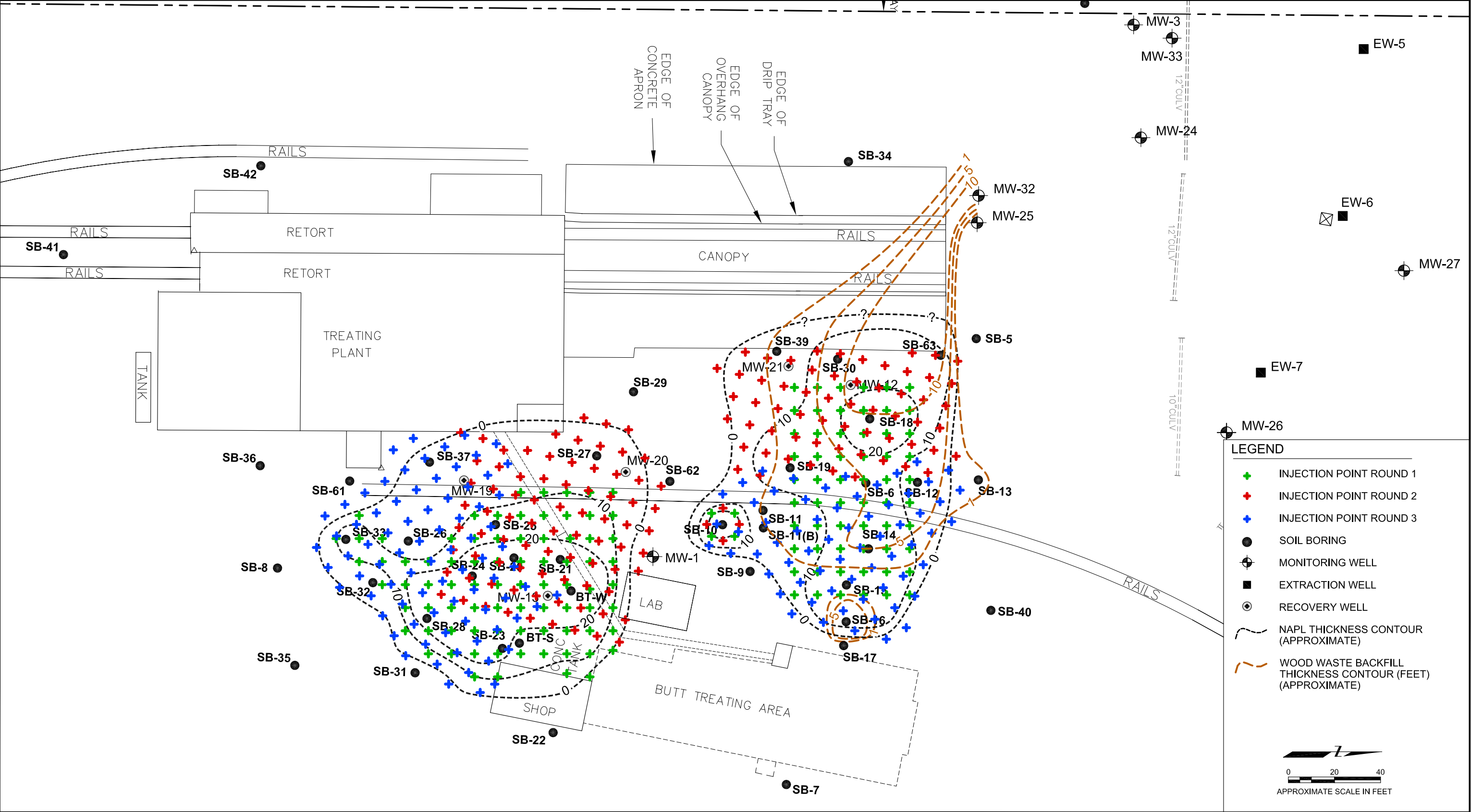
- Extraction Well
- Monitoring Well
- Biotreatment Point**
  - Dual Phase Extraction Well
  - Groundwater Extraction Well
  - ▲ Shallow Infiltration Point
- All Other Features**
  - Existing Infiltration Gallery Piping
  - ▭ Existing Infiltration Trench
  - - - Buried Distribution Piping
  - - - Estimated NAPL Extent



Date: January 23, 2017  
Data Sources: AMEC, ESRI, Air photo taken on  
May 2, 2015 by Google Earth







		CLIENT:		DWN BY:	PROJECT	DATE:	
		J.H. BAXTER		APS			FORMER J.H. BAXTER AND CO.
				CHK'D BY:	SB	WOOD TREATING FACILITY	PROJECT NO:
				DATUM:	-	ARLINGTON, WA	3-61M-125611
				PROJECTION:	-	TITLE	REV. NO.:
		SCALE:	AS SHOWN		ALTERNATIVE 6	A	
		AMEC			CHEMICAL OXIDATION AND ENHANCED	FIGURE No.	
7376 S.W. Durham Road Portland, OR. U.S.A. 97224			BIODEGRADATION RECIRCULATION		9-6		